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पुस्तकालय
गुरुकुल कांगड़ी

PERSIAN LITERATURE PRODUCED IN GUJARAT * DURING THE RULE OF THE SULTANS

DR. C. R. NAIK

Reader in Persian

Gujarat University, Ahmedabad–9

1

The wealthy province of Gujarat was conquered by 'Alāu'd-Din Khalji and annexed to the Delhi Sultanate in A.D. 1298–1299. The period between that date and A.D. 1401, was the first flush of the Muslim rule in Gujarat. It was one of the fairest provinces which having taken advantage of the weaknesses of the central authority and the confusion caused by Timur's invasion in A.D. 1398 threw off the imperial yoke. With the full concurrence of the nobles, first, Tatar Khan, the son and after his death, Zafar Khan the father, the erewhile 'nāzim' (viceroy) assumed the role of an independent king and the insignia of royalty with the title of Muzaffarshah. He was succeeded by his grandson, Ahmadshah, one of the greatest sultans of Gujarat (A.D. 1410–1442). It was he who built the Shahr-i-Mu'azzam[1] (the Great City) named Ahmadabad and adorned it with palaces and mosques which are still admired by visitors. During the reign (A.D. 1458–1511) of Mahmudshah Begarha, the greatest sultan of the dynasty, who was almost the mountain of a man with a long moustache[2] and stately person having an inordinate appetite, the prosperity of the kingdom culminated. He was succeeded by his son, Muzaffarshah II (Halim, A.D 1511–1525) who fought with the Rajputs under

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*Read at the 25th Session of the 'All-India Oriental Conference' held at the Jadavpur University, Calcutta.

[1] 'Ali Muhammad Khan, 'Khatima-i-Mir'at-i-Ahmadi', p. 3.

[2] Muhammad Qasim Firishta, 'Tarikh-i-Firishta', Vol. II, p. 404; Sikandar bin Muhammad (Manjhu), p. 100 (Bombay, A.H. 1308).

Medini Rai and restored Mahmud Khalji of Malwa to his throne. His son, Bahadurshah, the last of the most noted sultans of Gujarat (A.D. 1525–1537) was one of the ablest rulers of his time. After his death there was a series of weak kings in Gujarat. During their reigns, the administration was loose and there was confusion throughout the kingdom. Taking advantage of this, Akbar, the Mughal emperor conquered it and annexed it to his empire in A.D. 1572.

After this dynasty was stabilized, it became ready to make its individual contribution towards the Indo-Muslim culture. It was in the sphere of architecture that the enlightened policy and the liberal patronage of the sultans of Gujarat and their nobles, that stood out most prominently. It forms an important chapter in the history of the province. Not only this, they did not neglect the promotion of learning as well.

2

Persian enjoyed a privileged position in India during the Muslim rule and it was the court language in Muslim kingdoms. It was in Persian that poets eulogised their patrons and historians recorded the achievements of their masters. Several of the sultans of Gujarat extended patronage to Islamic scholars whether local or attracted to their court from different parts of India, Persia or any other foreign Muslim country. Some of them were themselves accomplished individuals and had an aptitude for poetic composition in Persian. For example, Sultan Ahmadshah is said to have been endowed with poetic genius. In A.D. 14_0 when Sayyad Burhanu'd-Din, Qutb-i-'Alam, the well-known saint of Gujarat from his residential place in Anhilapataka or mere Anhilwad or Nahrawala of Arab historians came to Ahmadabad in response to his invitation, he received him with a 'qasida' which he himself had composed, standing before him with the pose of a poet. The opening verse thereof is as follows[3] :

---

[3] 'Ali Muhammad Khan, 'Khatima-i-Mir'at-i-Ahmadi,' p. 26–27.

قطب زمانهٔ ما برهان بس است ما را   برهان او همیشه چون نامش آشکارا

[The Qutb (the Polar Star) of our time is (our) Burhan (a sufficient proof for us). He is the proof quite evident like his name.]

Sultan Muzaffarshah II (Halim) also possessed a taste for Persian poetry. It is said in this connection that Mulla Ayyub, his companion, who was a great poet and an eminent scholar was addicted to opium-eating. He once composed following verses in praise of the drug :

بخور ای خواجه ذرهٔ افیون   که ممدت بوقت باشد [4]
علما را مناسب است افیون   علم باید که با عمل باشد [5]

[Oh sir, eat a little opium so that it may give you stamina at once. Opium befits the learned. Knowledge must be with practice.]

Somebody conveyed this to the sultan who smiled and said, "The Mulla has not written the verses to incite people to eat opium. The writing of 'ب' (in 'بخور') instead of 'م' is the clerical error". And after changing the first letter of the first word he remarked, "The Mulla, in fact, had condemned opium-eating". All present were amazed at the quick-witted reply and complimented him on it.

Such were the sultans of Gujarat. There were poets and scholars attached to their courts. For example, the royal chronicler of Sultan Ahmad Shah, Halwa-i-Shirazi was a very good poet. Details about his work are given elsewhere in this paper.

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4. Sikandar bin Muhammad (Manjhu), 'Mir'at-i-Sikandari', p. 222 (M. S. University, Baroda).

5. (The beauty of the verses also consists in the play upon the word عمل.)
It admits of two meanings : (*a*) practice or acting upon and (*b*) an intoxicant. So the last himistieh can be translated as (1) knowledge should be with practice and (2) knowledge must be with an intoxicant (i.e. no knowledge without an intoxicant).

Sayyad Āsafkhan[6] who was appointed along with 'Azizu'l-Mulk Shaikh Khan Sultani by Sultan Mahmudshah Begarha to punish Shahryar Husamu'd-Din was a poet of no mean order. He composed a 'qasida' in imitation of a celebrated 'qasida' of Amir Khusraw known as Bahru'l-Abrar. As follows, two verses from it are quoted :

[7] گر فقیری بر در هرکس بگردد سگ بود
وز توانگر از فقیران رخ بگرداند خر است

توامان بد بود ماننده نحسی و نحس
زاده نیکو مشابه چون عبیر و عنبر است

[If a fakir turns to the door of every one, he is a dog and if a rich man turns his face away from fakirs, he is an ass.

One who is twin with evil is like an illfated person and makes (others) miserable and one born good is like ambergris and any such perfume.]

Faizullah Bimbani who belonged to a family of scholars and who dedicated some of his works to Sultan Mahmudshah Begarha had written in his preface to his 'Majma'un-Nawadir'[8] that in addition to his bigger works he had compiled a few treatises in prose and verse both in Arabic and Persian. His Arabic and Persian verses seem to have been lost.

Mulla Qani'i who flourished in the reign of Sultan Muzaffarshah II (Halim) could wield his pen equally well both in prose and verse. The details about his work will follow ;

---

6. Its variant reading is Sayyad Alif Khan in other books.

7. Shaikh Sikandar bin Muhammad (Manjhu), 'Mir'at-i-Sikandari', p. 149 (M. S. University, Baroda).

8. Muhmmad Ibrahim Dar, 'Literary and Cultural Activities in Gujarat', p. 39. This work reminds one of the well-known 'Chahar Maqala' of Nizāmi 'Arūzi Samarqandi. The subject-matter is the same, the only difference being that the 'Chahar Maqala' consists of four chapters while Faizullah's work is divided into forty chapters.

Malik Amin Kamal, the poet was a boon-companion of Sultan Bahadurshah. He had a fine sense of humour and repartee[9].

3

But the major portion of Persian literature produced in Gujarat during the rule of the sultans was contributed by Muslim saints. The reason is that throughout the history of Islam in India, missionary or itinerary preachers were relatively an important factor. Such conditions prevailed even in Gujarat. Usually these people were individuals endowed with piety and frequently men of learning. They received monetary help from the government and in return they emulated the ideas nourished by the sultans in the cause of their religion, but in their own peaceful ways

Thus Gujarat had been the hospitable home for the saints of sundry religious orders like Chishtiya, Suhrawardiya, Shattariya and Maghribiya. During the period under discussion they generally settled in the cities of Anhilwad Pattan and Ahmadabad, which were the strongholds of muslims. The ancestors of almost all of them belonged to Arabia or Persia and Arabic being the religious language, they studied it and through it, whatever learning they acquired. As the result most of their writings were in this language. Nevertheless, Persian being the court-language, some of them became well-versed in Persian and wrote books, as well, in it.

The most eminent of such saints was Shaikh Ahmad Khattu[10] Maghribi[11] Ganjbakhsh[12] (d. 849/1445). He was the spiritual adviser of Sultan Ahmadshah. He is chiefly remembered for the share he took in founding the new capital of Ahmadabad in (A H. 813[13] : A.D. 1411). Numerous miracles are attributed to him. About the mosque that he built near his residence at the village of Sarkhej[14], it is said that 'except the Moti Masjid at Agra, there is no mosque in India more remarkable for simple elegance[15]. Nearby there is over his tomb, a splendid mausolium which has an imposing structure, the largest of its kind in Gujarat. It is one of those noble buildings which have won for the capital of Ahmadabad, the charming epithet of 'Zainu'l-Bilad[16]' (the Beauty of Cities).

---

[9] Sikandar bin Muhammad (Manjhu), 'Mira't-i-Sikandari', p. 168 (M. S. University, Baroda).

[10] He was called Khattu because he lived for receiving religious instruction from his spiritual instructor, Shaikh Baba Ishaq at the place with the name situated in the vicinity of Ajmer.

[11] He was so called because he belonged to the Maghribiya Order of Sufis.

[12] He was given this epithet because he was too generous in his dealings.

[13] Ali Muhammad Khan, 'Khatima -i-Mir'at-i-Ahmadi', p. 1.

The saint wrote Persian verses under the pen-name, Ahmad. Some of them are cited below :

گذشتم من ازین دنیا چه طرفه کارها کردم
نداند ناقصان نکته ازین میدان چه گو بردم

[I renounced the world; as the result what wonders did I work ? The imperfect fellows do not understand the mystical signification as to what a ball I carried away from this plain.]

His following ruba'i is note-worthy :

در جهان بی وفا گردیم بسی   عاجزتر ز خود ندیدیم بسی
تازیانهٔ روزگار چیدیم بسی   ازدست‌خویش نه از دست کسی

[We moved much in this faithless world and we did not find many to be more helpless than ourselves.

We received, to a great extent, a scourging of the time by our own hand and not by the hand of anybody else.]

In his Persian book named 'Irshadu't-Talibin'[17], he has given the history of fourteen Sufi Orders. He translated into Persian the Holy Qur'an. The details about the same have been given elsewhere in the paper.

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14. About six miles south-west of the city of Ahmadabad.

15. 'East and West', September, 1905, the paper of Rev. George P. Tailor, Its title is 'Sarkhej, its Saint and its Kings'.
It has been further stated in it that the Masjidu'n-nabi at Madina does in its grand features bear a marked resemblance to the beautiful mosque at Sarkhej.

16. 'Ali Muhammad Khan, 'Khatima-i-Mir'at-i-Ahmadi', p. 1.

17. There is a manuscript thereof in the Hazrat Pir Muhammadshah Dargah Library, Ahmadabad.

The saint had an admirably good biographer in Abu'l Qasim alias Muhammad Qasim who collected the utterances of his spiritual preceptor under the title of 'Mirqatu'l-Wusul'. A perusal of the contents of this biography reveals that the saint was not only interested in reciting the beautiful verses of other poets but he himself also used to compose verses in Arabic, Hindustani as well as Persian. His biographer has quoted his Arabic verses, Hindustani 'dohas' and Persian ruba'is in his work.

Shaikh Mahmud Iraji also known as Shaikh Pir[18] (d.865/1458) was another devoted disciple of Shaikh Ahmad Khattu Maghribi, who recorded in 'his Tuhfatu'l–Majalis' the day-to-day utterances and miracles of the latter part of the life of the saint up to his death. It is a kind of diary. The language is simple and unadorned by any figures of speech. It provides a good specimen of Persian spoken in his time in Gujarat. Shaikh Mahmud Iraji was also a poet. Some of his verses are given below :

توئی سلطان عالم بی وزیری   توئی بی مثل و سند و بی نظیری
وی تو تاج و تخت ملکرانی   هر آن کس راکه خواهی شاه خوانی

[You are the ruler of the world and have no minister; you are without any equal or any authority and you are pre-excellent.

And you are the crown and the throne having the absolute sway; you (can) call a king whomsoever you please.]

Sayyad Burhanud-Din Abu Muhammad 'Abdullah Bukhari Suhrawardy better known as Quṭb-i-'Ālam (d. A.H. 857/A.D. 1452), whose descendants have been designatad as Qutbiya was a sufi of high spirituality. Even Sultan Muzaffarshah I went to pay a holy visit to him at his abode in Anhilwad Pattan. The saint shifted his residence from there to Ahmadabad at the request of Sultan Ahmadshah to which a reference has already been made. Numerous miracles are attributed to him.

---

[18] Ali Muhammad Khan, 'Khatima-i-Mira't-i-Ahmadi', p. 34.

He was the author of several books. His 'Marahmatnama-i-Burhani'[19] is a voluminous work. In it he has dealt with intricate problems of sufism in such a clear and simple way that the readers of common understanding scarcely fail to grasp the sense of its contents.

He was also a poet. Stray verses composed by him are found in different books One such has been given below :

[20] بجام هرکس هرگز شراب عشق کی گنجد
خوشا رندی که خم خم نوشد و نیاید ز وی بوئی

[How is the wine of love ever held by the cup of every body ? Happy is the fear-nought fellow who drinks it jar after jar and has no smell.]

Sayyad Uṯẖman (d. 863/1458) who was honoured with the title of Shama'-i-Burhani[21] by Sayyad Burhanu-d-Din Qutb-i 'Alam, his spiritual preceptor had a fine melodious voice and so he was chosen to preach the doctrines of his Suhrawardiya Order to his followers. He lies buried in the locality called Uṯẖmanpur after his name, which is situated near the well-known Vidyapeeth established by Mahatma Gandhi in Ahmadabad. He was a poet and composed fine ghazals in Persian under the nom de plume, Uṯẖman. Following verses from his ghazal[22] will serve as an illustration :

عرش فرشیست که در خلوت درویشان است
رنج گنجیست که هم در صحبت درویشان است

---

[19] A manuscript thereof lies in the personal library of Sayyad Musa Miyan Imam Haidar-bakhsh, the present Sajjada-neshin of Sayyad Muhammad Shah-i-Alam Suhrawardy Bukhari.

[20] Sayyad 'Abdu'r-Rahman Shah Budh, 'Manaqib-i-Burhani (MS. Hazrat Pir Muhammad Shah Dargah Library, Ahmadabad).

[21] Shaikh Sikandar Ibn Muhammad (Manjhu), 'Mir'at-i-Sikandari', p. 366 (M. S. University, Baroda).

[22] Mirza Muhammad 'Ali Muhammad Khan, 'Khatima-i-Mira't-i-Ahmadi', pp. 31-32.

خلعت و دولت جاوید اگر میخواهی
خرقهٔ باعظمت کسوت درویشان است
قصهٔ غرق شدن عالم و آن طوفان را
خوانده باشی که هم از زحمات درویشان است

[The throne of God is the mat which is in the solitary corner of dervishes; affliction is the treasure which is by the side of dervishes.

If you aspire for the ever-lasting honorific dress and wealth, it is the patch-garment of dervishes having the glorification of rich apparel.

You should have read the story of the deluge and the submersion of the universe; that is also due to the penances of dervishes.]

Sayyad Muhammed Shah-i-'Ālam (d. 880–1475) was a great saint of Ahmadabad. He took care of Sultan Mahmud-shah Begarha (when he was a mere child) against the trouble created by his foster-brother, Sultan Qutbu'd-Din and saved him by means of his spiritual powers[23]. There are so many miracles attributed to him, which are found recorded in books.

He was a learned man and was an incessant writer. He wrote several treatises in Persian like 'Risala-i-Sadiqiya', 'Risala-i-Mafateeh-i-Khazainullah', 'Risala-i-Muhammadiya' and 'Tuhfatu'l-Awliya.'

Sayyad Ahmad Jahanshah (d. 899/1494)[24], one of the Suhrawardiya sufis was the devoted disciple of the eminent saint, Sayyad Burhanu'd-Din Qutb-i-'Ālam. He had his convent in Anhilwad Pattan where he breathed his last. He was an erudite person and produced in Persian works like 'Safinatu'l-Ansab' and 'Dastur-i-Khilafat fi Adab-i-Mashaikh'.[25]

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[23] Shaikh Sikandar Ibn Muhammad (Manjhu), 'Mir'at-i-Sikandari', pp. 65–66 (Bombay, A.H., 1308).

[24] 'Abdu'r-Razzaq, 'Manaqib-i-Sayyad Ahmad Jahanshah (MS. in Persian).

[25] Sayyad Pyare-saheb Ghulam Muhammad Jahanshah, the descendent of the saint belonging to Anhilwad Pattan possesses the MSS. of both these works.

Qazi Mahmud (d. 920/1515), the disciple of the saint, Sayyad Muhammad Shah-i-'-Ālam who lies buried at Rasulabad[26], a village near Ahmadabad was a learned man and could compose elegant poetry in Persian. Some of his ghazals are very popular among the qawwals of Gujarat. As follows is a verse from one of his ghazals :

دارم دل گردان که من قبله نما می خوانمش
او سوی ابرویش کشد هرچند می گردانمش

[I gave away my unsteady heart to her as I consider her, the guide shownig the location of the Qibla; she draws me towards her eyebrow although I turn it aside.]

Shaikh Jamalud-Din better known as Jamman (d. 940/1533)[27] one of the Chishtiya sufis devoted all his time to imparting education in the madrasa attached to his convent. He wrote several books on multifarious subjects. His 'Risala-i-Mudhakira' on the subject of religion is his celebrated work. In it he has tried to explain in a simple language the fundamentals of Islam. He was also a poet and composed ghazals under the nom de plume, Jamman. Verses quoted below are from one of his ghazals :

[28]قطره و موج و حباب از بحر شد ۔ لیک موج و قطره و دریا یکی است
صورت حوا و آدم آفرید ۔ در حقیقت آدم و حوا یکی است
گرچه در فردوس اشجار اند بیش ۔ شد محقق کاندران طوبلی یکی است
همچو مجنون عاشق بیحد و بیعد ۔ لیک پنهان و عیان لیلی یکی است
چون بدریای جمالش غوطه خورد ۔ دید جمن دنیا و عقبلی یکی است

[The drop, the wave and the bubble got a rise from the ocean; but the wave, the drop and the ocean are one.

---

[26] Sayyad Imamu'd-Din, 'Tarikh-i-Awlia', p. 355 (Hazrat Pir Muhammad-shah Dargah Library, Ahmadabad, A.H., 1291).

[27] Mawlana Hadi Khan, ' Manaqib-i-Hafiziya ', p. 27 (Persian, A.H., 1301).

[28] Munir Muhammad, 'Shajratu'l-Mahmudiya', p. 95 (Urdu, Hyderabad, Deccan, A. H., 1304).

[29] Tuhfatu'l-Majalis translated from the original by Prof. Sayyad Abu Zafar Nadvi, p, 115 (Azamgarh).

He created the bodies of Eve and Adam; in reality Adam and Eve are one.

Although there are plenty of trees in the paradise, it has become positive that in it the Tuba (the name of a tree having the most delicious fruit) is one.

There are countless and innumerable lovers; but whether known or unknown Laila is one.

When Jamman dived (deep) into the ocean of Her beauty, he found that this world and the next world are one.]

Sayyad Ahmad also known as Shaikh Wajihu'd-Din Ahmad 'Alawi (b. 910/1504.[30] : d. 998/1589) [31] lived during and after the rule of the sultans. He originally belonged to the Shattariya Order of sufis. He was a very learned man and acquired mastery over every branch of knowledge current in those days and all sorts of sciences—secular and religions and esoteric and exoteric. He founded a 'madrasa' and himself worked in it as a teacher. After he became free from the teaching work, he devoted the remaining time to writing works. Most of them are commentaries in the Arabic language. A book entitled 'Awrad wa Ma'alumat-i-Hazrat 'Allama Shah Wajihu'd-Din 'Alawi[32] is in Persian and contains his precepts for his disciples. He was also a poet and composed verses in Persian under the takhallus, 'Wajhi'. Some of them have been cited below by way of illustration :

او سوار توسن ناز است من از پی روان
تا عنان‌گیری کنم چابک سوار خویش را
هر که در زلف تو آویزد دید از غصه جان
میکند مسکین پریشان روزگار خویش را

[She is the rider on a high-blooded steed of coquetry; I am merely walking behind to stop the progress of my steed-breaker.

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[30] Ali Muhammad Khan, 'Khatima-i-Mira't-i-Ahmadi', p. 69.

[31] Ibid., p. 70.

[32] There is a manuscript of the same in Hazrat Pir Muhammadshah Dargah Library, Ahmadabad.

Every one who hangs by your curly locks found on account of the strangulation of the soul that the poor fellow has to remain in a distressed condition.]

So it can be safely concluded that not a single poet of a high order flourished during the period, notwithstanding the keen interest shown by the sultans in the Persian language and literature. Nevertheless abundant materials in Persian mostly on religious and sufistic subjects were produced during the period. They consist of commentaries on different chapters of the Qur'an-i-Sharif and on the Prophet's Traditions, biographical sketches of celebrated sufis of different orders, tracts on music, prosody, Arabic grammar, mu'ammas (aerostics) etc.

4

Of special interest to the students of the history of Gujarat are the contemporary histories in Persian written during the period. It was the Persian learning in India that brought in its trail the art of writing history and the dynasties which succeeded the Delhi Sultanate had their own histories written in their kingdoms. So was the case in Gujarat.

There was a work entitled 'Muzaffarshahi'[33] giving in brief the account of the period of the founder of the dynasty from A.D. 1391 to A.D. 1411.

The Tarikh-i-Ahmadshahi[34] was written by the poet, Halwa-i-Shirazi whose mention has already come. It is in the maṯẖanwi form. In it, he has given an account of the achievements of Sultan Muzaffarshah and his master, Sultan Ahmadshah. The work is less of history and more of eulogy. It is a formalized and well-patterned narrative in the fulsome style of the day. It has the advantage of a few exact dates scattered in the verses.

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[33] No copy of this work is known to exist. Only a few stray references to the work are available in histories compiled during the later period.

[34] No copy of this work is known to exist but it has been extensively' quoted by the author of the 'Mira't-i-Sikandari'.

In the glorious reign of Sultán Mahmudshah Begarha, three historical works known after his name were written. One of them was the 'Tarikh-i-Mahmudshahi'[35]. It was compiled in A.H. 907 (A.H. 1501--1502) by Mulla[36]. 'Abdu'l-Karim Hamdani, one of the associates and followers of Mahmud Gawan, the popular Bahmani minister[37]. The author stayed for some time in Gujarat but later returned to his land. His 'Tarikh-i-Mahmudshahi' is the general history of the world and only about eighty pages have been devoted to the history of India. The language used is difficult and often obscure. The 'Ma'aṯẖir-i-Mahmudshahi[38] was written by a courtier of Sultan Mahmudshah. It is undoubtedly a very valuable history of the reign of the sultan, especially of the latter portion of his reign from A H 896 (A.D 1490) to A.H. 916 (A.D. 1510).

The 'Tabaqat-i-Mahmudshahi'[39] was written by Mawlana 'Abdu'l-Karim bin Ataullah who had come from Shiraz to

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[35] Three manuscripts of this work have been known to have been available– one, in the British Museum (OR 1819), the other in the India Office Library (No. 3842) and the third in a private library in Peshawar (according to Muhammad Ibrahim Dar in his " Literary and Cultural Activities in Gujarat ", p. 38).

[36] Rieu, "Catalogue of Persian Manuscripts in the British Museum", Vol. III, p. 967; Mahmud Qasim Firishta, 'Tarikh-i-Firishta, p. 357.

[37] Muhammad Ibrahim Dar has ascribed the authorship of this work to Faizullah Bimbani belonging to Bidar. According to him, he was deputed there as an ambassador by Sultan Mahmudshah Begarha. He has further stated that he belonged to a very learned family and he himself wrote a number of books. ('Literary and Cultural Activities in Gujarat', p. 38).

[38] Both Nizamu'd–Din Ahmad (in his 'Tabaqat-i-Akbari') and Muhammad Qasim Firishta (in his 'Tarikh-i-Firishta') have referred to the work without mentioning the name of the author. In the 'Tabaqat-i-Mahmudshahi' the author's name has been given as 'Abdu'l-Hasan in one manuscript and 'Abdu'l-Khaliq in another. Professor Muhammad Ibrahim Dar has mentioned Shamsu'd–Din Muhammad Zirak as the author of the work. ('Literary and Cultural Activities in Gujarat', p. 58).'

[39] The work was used by Nizamu'd-Din Ahmad and Muhammad Qasim Firishta while compiling their histories.

Ahmadabad[40]. It is a general history from the time of Adam up to A.H. 905 (A.D. 1499). In it, there are biographical notices of saints, learned men and divines in addition to the political history. The work is on the pattern of celebrated Arab histories.

The 'Tarikh-i-Muzaffarshahi' was written by Qani'i[40] whose full name was Mir Sayyad, 'Ali Kashani who came to Gujarat, spent some time and then returned to Isfahan.[41] It contains a valuable contemporary account of a single compaign of Sultan Muzaffarshah II to Malwa to liberate Mahmudshah Khalji from the over-weening hegemony of his Rajput Lieutenant, Medini Rai. The style of the work is the most ornate, florid and verbose of all chronicles. A major part of it consists of verses. The prose portion in it is epithet-ridden.

The 'Tarikh-i-Bahadurshahi'[42] was written by Husam Khan, a historian of merit. He was a courtier and an excellent military general with a family tradition of distinguished services under the sultans of Gujarat. The work was completed in A.H. 940 (A.D. 1533). It deals with the events from the beginning of the dynasty to the reign of Bahadurshah. Of all the works on the history of Gujarat, this was certainly the most detailed and possibly the most objective.

The 'Tuhfatu's-Sa'adat' was written by Aram Kashmiri for Sayyad Mubarak Bukhari. It seems to have been mainly a history of the sayyads of Gujarat but interspersed with numerous political details especially about the later sultans. Since Sayyad Mahmud Bukhari played an important role in the reign of Sultan Mahmudshah II, it also contains the events of that reign.

The 'Tarikh-i-Sadr-i-Jahan' is a universal history written by Faizullah bin Zainu'l-Ābidin bin Husain Ziyani who was better known by his title, Sadr-i-Jahan[43]. It was probably written in the first decade of the tenth century. Being a history on so large a scale, it is more concerned with the Islamic milieu than with India or Gujarat.

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[40] It was published by the Gujarat Vernacular Society, Ahmadabad with a long introduction and translation in Gujarati in A.D. 1942.

[41] M. A. Chaghtai, 'Sources of the Mir'at-i-Sikandari', (Journal of the Gujarat Research Society, Vol. VI, No. 1, January, 1944), p. 18, Fn 24.

[42] All the later historians derived benefit of the contents of this work.

'Ganj-i-Ma'ani[44] is a history of the reign of Bahadurshah in verse. Its author was a poet attached to that sultan and his name is given as Muṭi'. He wrote it in about A.H. 939 (A.D. 1532). It throws fresh light on the dealings of Bahadurshah with the Portuguese.

Of the large number of such works written during the period to commemorate the achievements of the sultans, only a few have escaped the ravages of time. Some of them like Halwa-i-Shirazi's 'Tarikh-i-Ahmadshahi,' Husam Khan's 'Tarikh-i-Bahadurshahi' and Ārām Kashmiri's 'Tuahfatu's-Sa'adat' live in pages of later historians like Nizamu'd-Din Ahmad, Muhammad Qasim Firishta, Shaikh Sikandar ibn Muhammad 'urf Manjhu and Ali Muhammad Khan Bahadur. All these histories written by officials or otherwise mostly reflect imperial views and contain an account of the description of royal pomp and grandeur. Their intention was to flatter their patrons rather than to express their own independent views. So, they twisted the facts to veil vices and defects, in such a way that even the base metal would appeal to readers as genuine. In consequence thereof, modern historians have to sift out facts from fictions.

5

There was a time when it was the question whether the Qur'an-i-Sharif could be translated into other languages or not.

The Muslim opinion in India asserted itself in favour of traslation and Persian rendering began to be available in Gujarat as well. There is a manuscript[45] of the Qur'an-i-Sharif in the Shrine of Shaikh Ahmad Khattu embodying Persian translation. It is attributed to the Shaikh by local tradition. In it at several places, the translation is explanatory. After it, translations mostly with commentaries of different chapters of the Qur'an were written by later scholars. The activity of translating other Arabic works into Persian was also prevalent.

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[43] Rieu, 'Catalogue of Persian MSS. in the British Museum', I, pp. 86–87.

[44] The only copy of it is in the Curzon Collection of the Royal Asiatic Society of Bengal, Calcutta (Ivanow, 'Concise Descriptive Catalogue of the Persian Manuscripts in the Curzon Collection,' Calcutta, Asiatic Society of Bengal, 1926, Book Bo. 251, p. 187–88).

Ibnu-l-Jazari, one of the great scholars belonging to Shiraz deputed Najib Shâfi'i to present his Arabic work called 'Al-Hasin' to Sultan Ahmadshah. This work was translated into Persian by Abu Bakr of Broach in the reign of Sultan Mahamudshah who evinced a keen interest in getting Arabic works translated into Persian. It was in his reign that the famous biographical dictionary[46] of Ibn-i-Khallikan was translated into Persian by Yusuf ibn-i-Ahmad under the title of 'Mazaru'l-Insan' and dedicated to that sultan in the year A.H. 889 (A.H. 1484-85). Similarly Ibn-i-Iyad's 'Kitabu'sh-Shifa' was rendered into Persian by Ibn-i-Afrash. He has mentioned in the course of his translation, certain incidents throwing a flood of light on the sultan's intellectual grasp of religious subjects, notwithstanding the fact that he had not studied religious and scholastic sciences in a regular manner.

Muhammad Gauṭ Gwaliyari (d. 970/1562), the first saint of the Shattariya Order of sufis to come to Gujarat for the propagation of his order during his stay in Ahmadabad translated the most popular of his several Arabic works into Persian with necessary improvements and called it 'Jawahir-.-Khamsa.'

6

One of the chief characteristics of the Persian prose literature in India is the growth and development of the laxicography. It redounds to the credit of Gujarat that one of its sons, Fazlu'd-Din. Muhammad bin Qiwam belonging to a small village named

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[45] Some pages in the beginning and at the end have been replaced in the course of time but the bulk of the work is intact in its original form.

[46] Wafayatu'l-A'yan ('Obituaries of Notable Men)'.

Kadi in its north compiled Bahru'l-Fazail as early as in A.H. 837 (A.D. 1439)[47].

From the above details it becomes quite evident that the contributors to Persian learning in the kingdom during the period under discussion were mostly the Muslim saints who had chosen this land for their residential place and the officials attached to the royal courts. They well laid the foundation for the Persian literature–religious, literary and historical–which was destined to exercise a potent and appreciable influence on the contemporary and later forms of the language, literature and religious thoughts of Gujarat.

In this way during the period, there was a large contingent of Persian scholars. All fruits of their incessant labour have been locked up in religious places like mosques and shrines as well as the private houses of their descendants. Anhilwada Pattan and Ahmadabad are the chief centres where they are located. So there are rich stores of ample research material for the scholars who would do well not to shirk toil and travail involved in pursuing quest with avidity, assiduity and fervency to make it available to the public.

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[47] Muhammad Ibrahim Dar 'Literary and Cultural Activities in Gujarat', p. 61.

AVIDDHAKARṆA — A FORGOTTEN NAIYĀYIKA

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We find the arguments of Aviddhakarṇa referred to and refuted quite a number of times in the Tattvasaṅgraha of S'āntarakṣita (8th–9th cent.) and the Pañjikā of Kamalaśīla on it*, and in Karṇakagomin's Tīkā (9th cent.) on Dharmakīrti's Svopajña vṛtti on the Pramāṇavārttika (pp. 19, 25, 90, 98). Aviddhakarṇa is always referred to in the discussion of the topics of the Nyāya system, so we can confidently say that he was a Naiyāyika. Moreover, his views are mostly given before those of Uddyotakara besides others, so we can infer from this that he was earlier than Uddyotakara. His way of reasoning also supports this surmise. It is surprising, nevertheless, that Aviddhakarṇa is not quoted by Uddyotakara or any other ācārya of the Nyāya school. We find him referred to for the first time in the Tattvasaṅgraha, and oddly enough Jñānaśrīmitra and Ratnakīrti, who have written a number of manuals on different topics and refuted the views of the thinkers of other schools, do not refer to Aviddhakarṇa. A work 'Tattvaṭīkā' of his is mentioned by Kamalaśīla, while discussing the validity of the syllogism for either party (–the speaker and the person addressed—kā. 1484).

Before we say anything or do any speculation concerning Aviddhakarṇa, we may at the outset examine the views and arguments of Aviddhakarṇa as given in the Tattvasaṅgraha and its Pañjikā.

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* Abhayadeva, the author of the Tattvabodhavidhāyinī-ṭīkā on the Sanmatiprakaraṇa, also refers to Aviddhakarṇa (See pp. 100, 332, 658, 674). But he clearly seems to have relied on Kamalaśīla's Pañjikā.

(A) In the section on Īśvaraparīkṣā (Tattvasaṅgraha, 46 ff), S'āntarakṣita introduces the topic by saying that some thinkers (e.g., the Naiyāyikas) declare God to be the cause of all things produced on the ground that no insentient thing (e.g., dharma, adharm, paramāṇu, etc.) can by itself produce its effects (kā. 46). Kamalaśīla adds that even the soul in which dharma and adharma subsist cannot be regarded as the required operator, because the particular soul at that time of the creation would be wholly a non-knower (–i.e., devoid of knowledge, which is a quality produced in it by virtue of the means of knowledge). So long as the aggregate of causes and effects, the body, sense-organs and the like, are not produced, the soul remains a non knower, not perceiving even such colour, etc. as are quite perceptible. Under the circumstances, how could it perceive dharma and adharma which are entirely imperceptible ? (See also Nyāyavārttika, 4-1-21, pp. 459–460). Aviddhakarṇa has put forth two arguments in proof of the existence of God, and Kamalaśīla seems to have quoted the very words of Aviddhakarṇa[1] :

(*i*) "Dvīndriyagrāhyā' grāhyaṁ vimatyadhikaraṇabhāvāpannam buddhimat-kāraṇapūrvakaṁ, svārambhakāvayavasannives'avis'iṣṭatvāt; ghaṭādivat; vaidharmyeṇa paramāṇavaḥ"—"The thing under dispute which is perceptible by means of two sense-organs or not perceptible at all, must be regarded as produced by an intelligent cause, because it is characterised by a particular arrangement of its own component parts, like the jar and unlike the atoms."

Giving an exposition of this, Kamalaśīla says that in this formulated argument, 'what is perceptible by means of two sense-organs' signifies the three kinds of substances, viz. earth, water and fire which are perceptible by means of the two organs of sight (darśana) and touch (sparśana) because they fulfil such conditions of perceptibility as being large (mahattva), being composed of several substances (anekadravyavattva), being coloured (rūpavattva) and the like.[2] 'The not-perceptible' (agrāhya) are air and the rest, because the recognised conditions of perceptibility are not present in them.

Now if this proposition were stated in the general form, viz. 'Things perceptible by two sense-organs and those imperceptible are produced by an intelligent cause' then it would involve the fallacy of siddha-sādhyatā—proving what is already admitted by both parties in regard to such things as the jar and the like and about which there is no dispute at all. It would, moreover, involve the fault of contradicting one's own doctrine (abhyupeta-bādha), because the Naiyāyika does not admit such imperceptible things as the atom, ākāśa and the like to be produced by an intelligent cause; and since these latter are eternal (and therefore not produced at all), the said assertion would involve the contradiction of perception and the like (pratyakṣādibādha). It is in order to avoid all these difficulties that the qualifying expression 'vimatyadhikaraṇabhāvāpannam', '(thing) under dispute' has been employed. The term 'vimati' stands for divergent views and that which forms the subject of divergent views is said to be the matter under dispute. With this qualification, what become the subject (pakṣa) of the argument are only the body, sense-organs, the various regions (bhuvana) and so forth; and what is stated does not apply to atoms and the like.

Similarly if the probandum were stated in the form, "(things under dispute) are produced by a cause", the argument would be superfluous,—proving what is accepted by both parties (– the fault of siddhasādhyatā). In order to avoid this, the qualification 'buddhimat kāraṇa-pūrvakam)' (produced by an 'intelligent' cause) has been added. The argument thus stated cannot be futile (– involving siddha-sādhyatā) as addressed to the Saṁkhya, as there is no intelligence (buddhi) in his view apart from Prakṛti, and surely a thing cannot be produced by itself in that form. 'Arrangement of its own component parts' (svārambhakāvayava-sanniveśa) signifies the conjunction in the form of aggregation of the parts that go to make things. By this the things in question are characterised. Mere 'characterisation by arrangement of parts' would be true of the universal 'cow' and the like which also are characterised by the arrangement of the parts that go to make the substances (i.e , the individual

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cow and the like) (but not themselves) and thus render the reason too wide (vyabhicārin); hence the qualification 'its own components' (svārambhakāvayava).

The intelligent cause thus established is God (kā. 47–48)

(*ii*) The second argument of Aviddhakarṇa proving the existence of God is as follows: "tanubhuvana-karaṇopādānāni cetanāvad-adhiṣṭhitāni svakāryam ārabhanta iti pratijānīmahe rūpādimat-tvāt, tantvādivat"[3] — The material causes (atoms and the like) of the body and the regions (bhuvana) produce their effect only when controlled by a Sentient Being — this is what we assert on the ground of their being endowed with colour, etc. — like such things as the yarn and the like (See Pañjikā, 49).

S'āntarakṣita has then given one argument adduced by Uddyotakara (kā. 50), then one by Pras'astamati and again other arguments by Uddyotakara. We may just note them so that they could be compared with those of Aviddhakarṇa. Uddyotakara's first argument as given by Kamalas'īla is: "bhuvanahetavaḥ pradhāna-paramāṇvadṛṣṭāḥ svakāryotpattāv atis'ayabuddhimantam adhiṣṭhātāram apekṣante, sthitvā pravṛtteḥ, tantuturyādivat' — The causes of the world in the form of Primordial Matter, atoms and unseen force need a controller with superior intelligence in producing their effects, because, their activity is intermittent, like the yarn, the shuttle and such other (causes of the cloth). (See Pañjikā, 50).[4]

There are other arguments put forth by Uddyotakara "buddhimat-kāraṇādhisthitam mahābhūtādikaṁ vyaktaṁ sukha-duḥkhanimittam bhavati; acetanatvāt, kāryatvāt, vinās'itvāt, rūpādimattvāt; vāsyādivat"—The manifest (world) consisting of the elemental substances and the like, is productive of pleasure and pain, (only) when controlled by an intelligent cause, (*a*) because it is insentient, (*b*) because it is a product, (*c*) because it is perishable, (*d*) because it is endowed with colour and the like—like the hatchet and the like (Pañjikā, 52–53).[5]

Praśastamati's argument as 'quoted' by Kamalaśīla is: "Sargādau puruṣāṇāṁ vyavahāro'nyopades'apūrvakaḥ, uttarakālam prabuddhānām pratyarthaniyatatvāt; aprasiddha-vāgvyavahārāṇāṁ kumārāṇāṁ gavādiṣu pratyarthaniyato vāg-vyavahāro yathā mātrādyupades'a-pūrvakaḥ" — All the usages of men at the beginning of the creation must have been preceded by (i.e. based on) the teaching of another, because later on, the usage of enlightened men (i.e. their usage after being enlightened) is found to be restricted to particular things, as for instance, in the case of boys who have not yet learnt the use of words, it is found that their usage of words as restricted to particular things is always preceded (and brought about) by the teaching of their mother or the like." (Pañjikā, 51). That is to say, that 'another' to whose teaching usages at the beginning of the creation are due is God, whose superior knowledge does not disappear even at the time of Universal Dissolution.

S'āntarakṣita has refuted the first argument of Aviddhakarṇa at length, and stated that this very refutation holds good according to the argument put forth, in the case of other thinkers who try to prove the existence of God.

Udayana's eight arguments proving the existence of God are very well known :

Kāryāyojana-dhṛtyādeḥ padāt pratyayataḥ s'ruteḥ;
vākyāt saṁkhyā-vis'eṣāc ca sādhyo vis'vavid avyayaḥ.
-Nyāyakusumāñjali, 5.1.[6]

It can be seen that Aviddhakarṇa has given the cosmological argument to prove the existence of God. Other Naiyāyikas also have done the same. But we find a greater variety in the arguments advanced by Uddyotakara and Pras'astamati (and of course Udayana) which can lead us to conclude that Aviddhakarṇa was earlier than Uddyotakara.

(B) Aviddhakarṇa's arguments proving the existence and the eternality and omnipresence of the soul also are found in the Tattvasaṅgraha and they seem to be actually quoted in the Pañjikā on it. The Naiyāyikas regard the soul as omnipresent, and eternal and as the substrate of qualities like knowledge, pleasure, pain, etc. which are produced in it from time to time. Aviddhakarṇa's argument to prove the existence of the soul is as follows: "Sadādyaviśeṣaviṣayāviṣaya-jñeyaviṣayā madiyāḥ pratyakṣānumānopamāna-s'abda-smṛti-prātibhajñāna-siddhadars'anārṣā"-rekaviparyayāḥ svapna-svapnāntikāḥ prajñānavis'eṣā madīyas'arīrādivyatiriktasaṁvedaka-saṁvedyāḥ; svakāraṇāyatta-janmavattva – sāmānyaviśeṣavattva – bodhātmakatvā "s'utaravinās'itva-saṁskārādhāyakatva – pratyayatvebhyaḥ; puruṣāntara-pratyayavat; vaidharmyeṇa pratyastamitaghaṭādayaḥ."

All my particular cognitions of such cognisables as substance, quality and action which are comprised under being, etc.[7] and also of generality, specific individuality and inherence which are not comprised under being, etc., which cognitions are perceptional or inferential or analogical or verbal or of the form of memory or intuitional or occult (astrological, etc.) or extraordinary (i.e. of ṛṣis or sages), or doubt or illusion or dreamy or dream-cognition—are apprehended by a cogniser distinct from my body, etc., (*a*) because their origination is dependent upon their own causes, (*b*) because they are general and particular, (*c*) because they are of the nature of consciousness, (*d*) because they are very quickly destructible, (*e*) because they leave impressions, (*f*) because they are cognitions,—just like the cognition of other persons, or unlike the jar, etc., that have perished" (Pañjikā, 177). This cogniser is the soul.

We may note here the arguments advanced by S'aṅkarasvāmin and Uddyotakara that are given by S'āntarakṣita and Kamalas'ila in their exposition of the prima-facie view in the Ātma-parīkṣā section. S'aṅkarasvāmin proves the existence of the soul differently: "icchādayaḥ kvacid ās'ritāḥ, vastutve sati kāryatvāt, rūpādivat"—Desire and the like must subsist in something, because while being existing entities (i.e. unlike destruction which is an effect but not an existing entity), they are effects, like colour, etc. (Pañjikā, 178).

S'āntarakṣita gives the gist of three arguments of Uddyotakara, and Kamalaśīla almost reproduces them:

(*i*) "Devadattasya rūpa-rasa–gandha–sparśa–pratyayā ekānekanimittāḥ; mayeti pratyayena pratisandhīyamānatvāt; kṛtasamayānām ekasmin nartakībhrūkṣepe yugapad anekapuruṣāṇām pratyayavat"—Devadatta's cognitions of colour, taste, smell and touch must be due to one (viz, cognizer) and to several causes (viz., cognisables) because they are recalled 'as (seen, etc.) by me' just like the simultaneous cognitions of several men who have come to an understanding among themselves, relating to the glances of the dancing girl." (Pañjikā, 180-181)[6].

This requires some explanation. When several men come to an understanding among themselves that when the dancing girl casts her glances, they should throw clothes to her, there are several cognitions by several cognisers, of the single object viz., 'glances'. Yet as the object cognised is one only, each man recalls the cognition as 'I have seen', 'I have seen'. Similarly here also the cognitions of several things would be recalled on account of their cause, viz., the cogniser being one only, and that one cause is the soul. The recalling of the cognitions also consists in their being grouped together in such notions as 'it has been seen by me', 'it has been heard by me' and so forth, as due to their belonging to a single cogniser. In the case of 'the glances of the dancing girl', however, what is meant to be stressed is only the fact of the cognised object (not the cogniser) being one. In all cases, however, the fact of the 'recalling' remains, due to which several cognitions become associated with a single entity.

Other arguments set forth as Uddyotakara's are: (*ii*) "Ātmeti padaṁ s'arīrendriya-manobuddhi–vedanā-saṁghāta-vyatiriktavacanam; prasiddhaparyāya – vyatiriktatve saty ekapadatvāt, ghaṭādis'abdavat."—The term 'soul' must be expressive of something different from the aggregate of body, sense-organs, mind, intellect and feelings–because it is a single term (unlike 'śaśa-viṣāṇa' which can be analysed into two distinct padas), while being distinct from the well-known synonyms (of body, etc.), like such terms as 'jar and the like' (Pañjikā, 182-183)[9].

(*iii*) "Nedaṁ nirātmakaṁ jivaccharīram, aprāṇādimattva-prasaṅgād, ghaṭādivat"—This living body is not soulless, because if it were so, it would be devoid of the functions of breathing, etc. like the jar, etc. (Pañjikā, 184). This is a negative argument in proof of the existence of the soul.[10]

It can be seen that Aviddhakarṇa's argument is more subtle in a way than those of S'aṅkarasvāmin and Uddyotakara in as-much as he posits the soul as that which is required to be aware of the cognitions, whereas the latter posit the soul as the substrate of the qualities, desire, etc., or as the connecting link between different cognitions, or as the thing denoted by the word 'ātman' (soul) or as the enlivener of the body.

Aviddhakarṇa's reasoning in support of the eternality and omnipresence of the soul is also found quoted in the Pañjikā (185–186): "Māturudara-niṣkramaṇottarkālam madiyādyapra-jñāna–saṁvedaka–saṁvedyāny anyatatkālāni madiyāni prajñā ā n; madīyaprajñānatvāt; ādyamadīya–prajñānavat"—The cognitions that I have had since my birth must have had the very cogniser who had the first cognition immediately after my emerging out of my mother's womb—because they are my cognitions,—like my first cognition (Pañjikā, 185). This proves the eternality of the soul. In proof of the omnipresence of the soul, Aviddhakarṇa sets forth the argument: 'Avanijalā'nila–manāṁsi vipratipattiviṣaya-bhāvāpannāni dūrataravarttīni madiyenātmanā saha saṁbadhy-ante; mūrttatva – vegavattva – paratvāparatva – mithaḥsaṁyoga-vibhāgavattvebhyaḥ; madīyaśarīrādivat". The earth, water, air and mind which are things under dispute, are at a distance from my soul and yet they are in contact with that soul—(*a*) because they have material form, (*b*) because they have velocity, (*c*) because they have priority and posteriority, (*d*) because they are associated with, and dissociated from each other, just like my own body (Pañjikā, 186).

(C) In the section 'Sthirabhāvaparikṣā' (Examination of the durability of things), S'āntarakṣita tries to prove that everything is in a perpetual flux and that destruction is independent of any cause. In this connection, S'āntarakṣita sets forth the arguments of Aviddhakarṇa in proof of destruction having a cause, in order to refute them. It may be noted that here Kamalaśīla does not attempt to quote or reproduce Aviddhakarṇa's argument, which may lead us to infer that in other cases he had the text of Aviddhakarṇa's writting before him. Aviddhakarṇa's arguments as given by S'āntarakṣita are as follows:

(*i*) "Nanu naiva vinās'o'yaṁ sattākāle'sti vastunaḥ,
na pūrvaṁ na cirāt pas'cād vastuno'nantaraṁ tv asau;
evaṁ ca hetumān eṣa yukto niyatakālataḥ,
kādācitakatvayogo hi nirapekṣe nirākṛtaḥ".

—This destruction of the thing is certainly not present at the time that the thing is in existence (for if it were present, then the momentarily existent thing could not exist). Nor is it present before (the thing has come into existence, as what is not born, e.g. son of a barren woman, cannot be destroyed), nor very long (after the thing has come into existence, because all things being destroyed at the third moment of existence, there cannot be another destruction very long afterwards, as is found in the case of fire that has become reduced to ashes). The destruction of thing, therefore, must come immediately after it has come into existence (i.e., at the second moment). Thus, inasmuch as it comes into existence only at a particular time, it must have a cause. If it were independent (of all causes) then this occasional character would be impossible as shown above (Tattvasaṅgraha, 367–368). The other arguments are given in kārikā, 369: "Vastvanantarabhāvāc ca hetumān eva yujyate abhutvābhāvatas' cāpi yathaivānyaḥ kṣaṇo mataḥ" : (*ii*) Destruction must have a cause as it comes immediately after the thing; (*iii*) also, because not having been in existence, it comes into existence, just like the following moment (point-instant).

In this connection, S'āntarakṣita has given the argument of Uddyotakara also, and Kamalas'īla has reproduced it in his Pañjikā:

Vināś'asya hetur nāstīti bruvāṇaḥ paryanuyojyaḥ kim akāraṇatvād vināśo nāsti vyomotpalādivat; athā'kāraṇatvān nityo vyomādivad iti. Bhavatāṁ hi pakṣe akāraṇaṁ dvidha dṛṣṭaṁ—nityam asac ca, na hi sattvā'sattvavyatirekeṇa prakārāntaram asti. Tatra yady akāraṇatvād asat vinās'ah, tadā sarvabhāvānāṁ nityatvaprasaṅgaḥ, vināś'ābhāvāt; kiṁ ca, sarva— saṁskārā vinas'yantī'y eṣa pratyayo nirnimittaḥ prāpnoti, na hy asatyāṁ gatau gacchatīti bhavati. Atha nityaḥ, tadā bhāvasya vināśena sahā'vasthānam prāpnoti, sarvadā'vasthānāt; na caitad yuktam, bhāvābhāvayoḥ parasparaparihārasthitalakṣaṇatvāt; atha sahāvasthānaṁ neṣyate, tadā kāryasyotpādo na prāpnoti, tat-pratyanīkabhūtasya nāśasya sadā''sthitatvāt; tatas'cā'jātasya vināś'o' pi na saṁgacchate, na hy ajātāḥ śaśaviṣāṇādayo vinas'yantīti loke pratītaṁ, tenā' jātasya vināś'a iti vacanaṁ naiva yuktyanupāti (Pañjikā, 370-372)[11].

(One who holds that there is no cause for destruction should be questioned as follows: Does this mean that there being no cause for destruction, destruction does not exist (i e does not occur) at all, like the sky-lotus, or that having no cause, it is eternal like ākāśa and the like? In your view, what is causeless is found to be of two kinds—eternal and non-existent; there is no other alternative to these two, viz. existence and non-existence. Now, if being without a cause, destruction be regarded as non-existent, then all things would be eternal, as there would be no destruction at all. And the idea that 'all properties become destroyed' would then become baseless, because where there is no movement, the idea of anything moving is impossible. If, on the other hand, having no cause, destruction is eternal, than it obtains that a thing co-exists with its destruction which is always there. And this would be highly improper, as the presence and absence of a thing are mutually exclusive in character. If then the said co-existence be not admitted, then there could be no producing of any effect, as its contrary, the destruction, would always be there; and when a thing is not produced at all there can be no destruction of it; for instance, such unproduced things as the hare's horn are not known to be destroyed. Hence the assertion that 'there is destruction of what has not been produced' cannot be in keeping with reason.)

It can be seen that Uddyotakara's argument is a product of the age when dialectical discussions had started coming into full swing, while Aviddhakarṇa's arguments to the same effect, are of an earlier period.

(D) In the 'Dravyapadārtha-parikṣā' section of the Tattvasaṅgraha, S'āntarakṣita has refuted the concept of 'eternal atoms. Herein while giving the prima-facie view, he refers to the argument of Aviddhakarṇa in proof of the eternality of atoms (kā.552). Kamalas'ila has reproduced this argument in the Pañjikā :

"Paramāṇūnām utpādakābhimataṁ saddharmopagataṁ na bhavati; sattvapratipādaka-pramānāviṣayatvāt, kharaviṣāṇavat"— what is held to be the producer of atoms cannot be endowed with the property of existence, because it is not cognised by any means of right cognition indicating existence, like the ass's horn'. The arguments of other Naiyāyikas are not given in this connection.

(E) (*a*) In the 'Guṇapadārthaparīkṣā' section while refuting the reality of the quality 'number', S'āntarakṣita refers to Aviddhakarṇa's argument proving the existence of number, and this argument is found reproduced in the Pañjkā (643): 'Saṁkhyā-pratyayo gaja-turaṅga-syandanādivyatirikta-nibandhanah gajādi - pratyayavilakṣaṇatvāt, nīlapaṭa-pratyayavat "—

The notion of 'number' must have a basis other than such things as the elephant, horse, chariot and the like, because it is different from the notions of the elephant, etc., like the notion of 'blue cloth'.

(*b*) In the same section, arguing that number, conjuntion, etc., are just conceptual constructions, having no objective reality S'āntarakṣita anticipates Aviddhakarṇa's rejoinder (kā. 678) and refutes it. This argument proving the reality of group (samūha) and the like is quoted by Kamalas'īla: "Samūha-santānāvasthā-vis'eṣās tattvānyatvābhyām avacanīyā na bhavanti; pratiniyata-dharma-yogitvāt; rūparasādivat". The particular states of the group and the chain are not incapable of being defined as this or not this, because they are endowed with distinctive features, just like colour, taste and such things (Pañjikā, 678).

From the above arguments of Aviddhakarṇa it is clear that he had in view some opponent (most probably the Bundhist), and that is why in the case of most of the padārthas (categories), he has tried to prove their reality, without entering into much dialectical discussion, so characteristic of Uddyotakara.

(F) Aviddhakarṇa is found quoted again in connection with the discussion pertaining to the syllogism. The Buddhists hold that the syllogism should consist of only two members (e.g. yat kṛtakaṁ tat sarvam anityam, kṛtakas' ca s'abdaḥ) so they regard the nigamana (conclusion) as superfluous. Aviddhakarṇa's argument in support of the utility of the nigamana is as follows :

> " Viprakirṇais ca vacanair naikārthaḥ pratipādyate; tena sambandhasiddhyarthaṁ vācyaṁ nigamanam pṛthak "—

A single idea cannot be expressed by diverse isolated assertions; hence for bringing about the connection between these assertions it is necessary to state the final conclusion " (Pañjikā 1410).

Here for once S'āntarakṣita has referred to and refuted the argument of Uddyotakara and others, before refuting Aviddhakarṇa's argument. Diṅnāga had argued that in asmuch as the nigamana (conclusion) is a mere repetition it cannot be the means of proving anything (nigamanam punaruktatvād eva na sādhanam). Against this Uddyotakara and others have argued thus: "Na paunaruktyam atra, yasmāt sādhya-nirdes'aḥ pratijñā, nigamanaṁ tu siddha-nirdes'aḥ; 'punaḥ'-s'abdaḥ* sādṛśye, tena pratijñā-sadṛs'aṁ vacanam ity uktam bhavati; na ca nigamanena vinā siddhir asti; tathā hi—tena vinā tadanyāvayavoktāv api s'aṅkā na nivartate–kim anityaḥ s'abda iti, atas tadās'aṅkānivṛttyarthaṁ vācyam nigamanam pṛthag"—There is no repetition here, because the proposition (pratijñā) states the probandum as to be proved, while the final conclusion (nigamana) states it as proved; 'punaḥ' signifies similarity; so the nigamana is similar to the pratijñā; and without the final conclusion there can be no proving; because until that is stated, even though the other members of the reasoning be stated, the suspicion as to whether, for instance, word is really non-eternal or not, does not cease; hence for the removal of this suspicion, the final conclusion has to be stated separately (Pañjikā, 1439).

The reason why S'āntarakṣita has taken up for consideration the argument of Uddyotakara and others before that of Aviddhakarṇa may be that the former have shown specifically the utility of the nigamana, while the latter simply regards it as an assertion showing the connection of the other members of the syllogism which apparently seem to be unconnected. Ultimately these are two different ways of answering the same objection. Moreover it is note-worthy that Aviddhakarṇa is always mentioned alone, whereas Uddyotakara, Bhāvivikta and the [illegible] are bracketed with others (cf. Bhāviviktādayaḥ—Pañjikā, 1437; Uddyotakarādayaḥ—Pañjikā, 1439).[12]

(G) The Bārhaspatyas (Cārvākas) do not regard inference as a means of valid knowledge (pramāṇa). While referring to the arguments of the Cārvākas against regarding anumāna as a pramāṇa, it is said by S'āntarakṣita and by Kamalas'ila, who gives an exposition of his kārikās, that according to the Cārvākas no inference is infallible and there is always a possibility of several undesirable contingencies being put forth. Moreover, it is always possible to find a reason that is concomitant with the contrary of the desired conclusion. For example, against, the argument, "Word is non-eternal, because it is a product, like the jar", someone may advance the argument, "Word is eternal, because it is perceptible by the ear, like 'wordness' (the universal 'word')". Kamalaśīla notes here that several such examples may be found in the Tattvaṭīkā (evamādis Tattvaṭīkāyām udāharaṇa-prapañco draṣṭavyaḥ—Pañjikā, 1458). This Tattvaṭīkā was a work of Aviddhakarṇa as can be seen from Pañjikā, 1484. From this we can say that Aviddhakarṇa must have given in his Tattvaṭīkā a number of such syllogisms while discussing and illustrating the hetus (valid reasons) and hetvābhāsas (fallacious reasons). The Tattvaṭīkā seems to be a commentary on some Nyāya work earlier than Uddyotakara's or even on the Nyāya-bhāsya,* wherein he tried to justify the Nyāya position and defend it against attacks, especially those of the Buddhists.

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*' Hetvapadeśāt pratijñāyāḥ punarvacanaṁ nigamanam iti nigamana—lakṣaṇam.

(H) It is an interesting problem in philosophy as to how the sceptics, the Mādhyamikas, and the Kevalādvaitins who do not recognise any empirical means of true knowledge, not even inference, can discuss with their opponents. Their argument is that they use the enemy's weapons to fight them. In connection with inference one can also say that the syllogism (parārthānumānam) cannot be a pramāṇa for the speaker for he already has the knowledge of what he wants to convey to the other party. Aviddhakarṇa has mooted a similar problem in his Tattvaṭīkā: "Nanu vā pramāṇena kim iti paraḥ pratipādyate, ubhayasiddhaṁ hi pratipādakam bhavatīti; tad etad ayuktam; yasmād vacanātmakam anumānam, na ca vaktuḥ pramāṇam; atha ca vaktā tena param pratipādayati, para-pratipādanārthatvāt prayāsasya, nāvaśyam ubhayasiddhena prayojanam".—It maybe asked: "Why is it that a pramāna (means of knowledge) is made use of to convey something to the other person, when only what is admitted by both the parties (—the speaker and the person addressed) can convey any idea?" But this is not proper, because inference is in the form of a verbal statement; and it is not a means of right cognition for the person making the statement; and yet that person conveys the idea expressed to the other person as his sole effort is towards the conveying of the idea to that other person; hence the means need not necessarily be admitted by both the parties. (Pañjikā, 1484).

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* See 'Geschichte Der Indischen Philosophie', Vol. II, p. 7—Erich Fraulwallner (Otto Müller Verlag).

Vatsyāyana and others also have attempted to discuss a similar point in connection with vitaṇḍā as to how a person can discuss if he has no view of his own. They half-heartedly come to the conclusion that when a vaitaṇḍika refutes the view of the opposite party by trying to prove the opposite, that latter becomes his own view. Aviddhakarṇa's stand seems to be a bolder one. He has justified the use of inference even though a person may not recognise it as a means of valid knowledge because his only purpose is to convey something to the other person who recognises its validity and that is served. Whether he himself accepts it as such or not, or admits the reality of what he is saying is a different point altogether.

(I) The Buddhists do not recognise upamāna (analogy) as a pramāṇa because it acquaints us with what is already known, viz., the connection of the name with the thing (saṁjñā-saṁjñi sambandha). After refuting the Mīmāṁsaka's conception of upamāna and then the Naiyāyika's view, S'āntarakṣita refers to Aviddhakarṇa's justification of upamāna as a distinct means of valid knowledge (Tattvasaṅgraha, 1567-1568). Kamalaśīla has quoted the words of Aviddhakarṇa: "Āgamāt sāmānyena pratipadyate, vis'eṣa-pratipattis tūpamānāt" (Pañjikā, 1567)—From the verbal testimony (of the forester, viz, a 'gavaya' is like a 'go'), one just understands that the name 'gavaya' can be given to an animal that is like the 'go'; but by means of upamāna, he comes to know the relation of the name 'gavaya' with a particular entity, hence there is some additional knowledge attained through upamāna, which can thus be a distinct means of knowledge (Compare Nyāya-vārttika, 1 1.6).

(J) Similarly, in refutation of the Buddhist view that there are only two pramāṇas corresponding to the two prameyas (cognisables)– svalakṣaṇa (extreme particular) and sāmānyalakṣaṇa (universal), Aviddhakarṇa has put forth the following argument : " Pratyakṣam anumānavyatirikta - pramāṇāntara–sadvitīyam, pramāṇatvāt, anumānavat; anumānaṁ vā pratyakṣavyatirikta-pramāṇāntara–sadvitīyam, pramāṇatvāt, pratyakṣavat. Tathā svalakṣaṇaṁ sāmānyalakṣaṇavyatirikta – prameyārthāntara – sadvitīyam, prameyatvāt, sāmānyalakṣaṇavat; sāmānyalakṣaṇaṁ vā svalakṣaṇavyatirikta-prameyāntara-sadvitīyam, prameyatvāt, svalakṣaṇavat"– Perception is accompanied by another pramāṇa, over and above inference, because it is a pramāṇa, like inference; or inference is accompanied by another pramāṇa over and above perception, because it is a pramāṇa, like perception. Similarly, the extreme particular is accompanied by another cognisable over and above the universal, because it is a cognisable, like the universal, or the universal is accompanied by another cognisable over and above the extreme particular, because it is a cognisable, like the extreme particular" (Pañjikā, 1583).

Of course, this is verbal jugglery and S'āntarakṣita rightly says that thus one can go op proving as many pramāṇas and prameyas as one likes which would go against the position of the Naiyāyikas themselves (See Tattvasaṅgraha, 1583–1585 .

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Karṇakagomin (9th cent.) also has referred to Aviddhakarṇa four times in his Ṭīkā on the Svopajñavṛtti of Dharmakīrti on his Pramāṇa-Vārttika (Svārthānumāna–pariccheda), when he answers the objections of the Naiyāyikas aganist the logical views of the Buddhists

(K) After proving the trairūpya (three-fold characteristic) of the liṅga (probans), Karṇakagomin says that the objection of Aviddhakarṇa is thus answered. Aviddhakarṇa argued :

" Satyam anumānam iṣyate evā'smābhiḥ pramāṇam lokapratītatvāt, kevalaṁ liṅgalakṣaṇam ayuktam" (p. 19)— True we accept inference as a valid means of knowledge because it is empirically known (loka-pratīta) as such, only the definition of the liṅga (probans) is not proper ". Karnakagomin retorts that even the trairūpya of the liṅga is loka-pratīta.

(L) While proving that anumāna (inference) is a pramāṇa like perception, Karṇakagomin says that the cognitions of the anumeya (probandum) (viz. svabhāva or kāraṇa) though not illuminating the respective point-instants of reality are yet invariably connected with them as they indirectly originate due to them, so inference is a pramāṇa like perception. So Aviddhakarṇa's objection stands refuted. Aviddhakarṇa's argument was: "Anadhigatārtha-paricchitiḥ pramānam ato nānumānam pramānam artha-paricchedakatvābhāvat' (p. 25)-pramāna is the apprehension of a thing not cognised before so anumāna is not a pramāna as it does not apprehend a thing".

Karṇakagomin's stand point is that one resorts to a pramāṇa in asmuch as it points to a thing with reference to which some activity is possible. Perception also leads one to operate with respect to a thing by determining that it is the same efficient thing as was perceived earlier in the continuum. So also inference.

(M) Karṇakagomin (pp. 90–91) further refers to the arguments advanced by Adhyayana, Aviddhakarṇa and Uddyotakara in connection with the refutation of the Buddhist theory of momentariness and that destruction is independent of any cause. (See C.) This occurs in the exposition of the relation of invariable concomitance (vyāpti) based on svabhāva (identity).

(N) Similarly showing the relation of causality as the other basis for the vyāpti, Karṇakagomin says that two thing are known as cause-effect as one is perceived after the other and is also remembered as such. Aviddhakarṇa's objection is that in the view that all things are in a flux, no memory is possible, and there will not be any one who could connect the two knowledges; and one cannot remember what another has experienced. (Aviddhakarṇas tv āha "avinābhāvitvam ekaṁ dṛṣtvā dvitiyādi darśane sati sidhyati; na ca kṣaṇikavādino draṣṭur avasthānam asti; na cānyenānubhūte' rthe anyasyāvinābhāvita-smaraṇam asty atiprasangād" iti (p. 48).

Karṇakagomin refutes this on the ground of the two phenomena occurring in one and the same continuum (santati) both in respect of the object as also the cognition.

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Having had some idea of Aviddhakarṇa's views and arguments from the 'quotations' in Kamalaśīla's Pañjikā, we may now see if we can say or guess something regarding Aviddhakarṇa. Looking to the attractive names of the other ācāryas (e. g. Uddyotakara, Bhāsarvajña Bhāvivikta and the like), one can confidently say that 'Aviddhakarṇa' is a nick-name signifying 'one whose ears are not pierced (or split)'. This again reminds us of others whose ears were split, for otherwise this negation would have no force. And those who are well-known for having their ears split are the Kānphaṭa yogins. Let us see if Aviddhakarṇa could have been in any way connected with these.

The Naiyāyikas are known to be S'aiva by faith, and Jālandharapā, Matsyendranātha, Gorakhanātha and the like are also known to be S'aivas. The distinctive marks of the sect of Kānphaṭas are the split ears and the huge earrings. In the final stage of their ceremony of initiation a specially chosen guru, or teacher, splits the central hollows of both the ears with a two-edged knife. Aughaḍas (novices) are said to be followers of Gorakhanātha who have not undergone the final ceremony of having their ears split. A legend is current which serves to justify them in not completing the initiation. Once two siddhas (perfect yogins) tried to split the ears of a candidate, but they found that their slits closed as fast as they were made. Since then the Aughaḍas have dispensed with the custom.[13] While many Aughaḍas intend completing their initiation, there are some Gorakhanāthīs who always remain Aughaḍas. Some of these Aughaḍas are wealthy and in good repute. They have their own monasteries. Some claim to have magical powers and some even approximate the Aghori. Others say that they are followers of Kānipā, pupil of Jālandharapā. Jālandharapā and Kānipā are sometimes identified with the Aughaḍas, while Matsyendranātha and Gorakhanātha are known as Kānphaṭas. The sphere of activity of the former was Bengal and Bihar, that of the latter was the United Provinces and the Panjab.[14] According to certain traditions that have been preserved, Jālandharapā and Matsyendranātha are regarded as direct disciples of Ādinātha (regarded as S'iva himself); or Jālandharapā is regarded as even earlier than Matsyendranātha. He was the founder of the Pā panths as over against the Nātha Panths.[15] These belonging to the Pā panths or the Nātha panths were associated in one way or the other with the (Tāntrika) Buddhists, especially in respect of tantric views and practices.

The date of Jālandharapā, Matsyendranātha, Gorakhanātha and others cannot be fixed with certainty. After examining all the data available, Briggs in his 'Gorakhanātha and the Kānphaṭa Yogīs' (pp. 249 ff) comes to the conclusion that the evidence regarding Gorakhanātha's date may be grouped round four periods:

(*i*) Age of Kabir and Nanak, (*ii*) 11th–12th centuries, (*iii*) 7th–8th cent., (*iv*) still earlier times. Briggs holds that Gorakhanātha lived probably early in the eleventh century and that he came originally from Eastern Bengal.[16] Nevertheless, he acknowledges that the conjecture about 7th–8th centuries is also properly supported for there is the Buddhist–S'aivite tradition in Nepal going back to Narendradeva; Bappa of Udaipur, Rasālū and Hodi of the north west; and scraps of references about S'aṅkara in the east and in Nepal. It is well to bear in mind that the S'aiva movement was advancing powerfully in the days of S'aṅkara (788-820). The struggle between Buddhism and S'aivism was at its height in South India in the seventh century. S'aivism was introduced into Nepal early and in 627 A.D. there were seven S'aivite shrines in Nepal.[17] Jālandharapā was even earlier than Gorakhanātha.

This date (7th-8th cent.) assigned to Gorakhanātha agrees well with the date of Aviddhakarṇa who lived before S'āntarakṣita (8th-9th cent.) and even Uddyotakara (7th cent.). It is likely that he was one of those S'aivites amongst whom the custom of splitting the ears was not observed, and who were probably the followers or even the direct disciples of Jālandharapā. It is a known fact that there was rivalry in the early stages between these two sects, headed by Jālandharapā and Matsyendranātha (- the custom of getting the ears split seems to have originated with the latter). It is likely that the direct pupils of Jālandharapā did not observe this practice, and Aviddhakarṇa was one of them. He was either ridiculed as one who did not have split ears by his opponents, and the nick-name became popular and stuck, or he himself took pride in calling himself 'one whose ears were not split', that is to say, on being self-disciplined, rather than derive his merits and strength from the guru. The fact that he is known to S'āntarakṣita and Kamalas'īla and Karṇakagomin and not to the ācāryas of the Nyāya school proper also supports this, for as said above these Aughaḍis and yogīs were directly connected with (Tāntrika) Buddhists, while the Naiyāyikas proper (though belonging to S'aiva faith) had only an academic interest in Buddhism and perhaps did not participate in tāntrika practices, and live in monasteries of any type. Aviddhakarṇa was one who while belonging to some panth—probably of the following of Jālandharapā—was also an intellectual who commanded respect and hence is quoted a number of times by S'āntarakṣita and Kamalas'īla and Karṇakagomin who perhaps were associated with the same places as Aviddhakarṇa sojourned through and so were familiar with his writings and views. Kamalas'īla has referred to Tattvaṭīkā as a work of Aviddhakarṇa. This Tattvaṭīkā seems to have been a commentary on some Nyāya work earlier than Uddyotakara's, or even on the Nyāya-bhāsya, in which he had profusely illustrated by means of syllogisms the hetus and hetvābhāsas, as also defended the Nyāya position especially against the Buddhists. Moreover, we have seen that Aviddhakarṇa is never found included in 'Uddyotakara and others', but his view is always found separately given. This means that his way of reasoning did not belong to the same school as that of Uddyotakara and others, and perhaps his way of life also was different enough to deserve special mention.

If our speculation has any truth in it, this will furnish one sure evidence as regards the date of the Kaṅphaṭas. Aviddhakarṇa can be regarded as a junior contemporary and the direct disciple of Jālandharapā, and to have lived in the later part of the sixth century or in the early part of the seventh century.*

Notes

(1) When Kamalaśila quotes the arguments of Uddyotakara (e.g. in Pañjikā, 50), many a time we find that the idea is there in the Nyāya-Vārttika of Uddyotakara (e.g. Nyāya-Varthika, 4. 1. 21), but the exact words are not there; that is to say, Kamalaśila generally reproduces the sense of Uddyotakara's argument, though at times we find that there is an exact reproduction (compare Pañjikā, 180 with Nyāya-vārttika, 1. 1. 10). This might be true of Aviddhakarṇa's arguments also as given in the Pañjikā.

I have freely used Gaṅgānātha Jhā's Translation of the Tattvasaṅgraha and its Pañjikā with changes where found necessary.

(2) See Vaiśeṣika sutra 4. 1. 6-8 — Mahaty anekadravyavattvād rūpāc copalabdhiḥ; adravyavattvāt paramāṇāv anupalabdhiḥ; rūpasaṁskārābhāvad vāyor anupalabdhiḥ.

(3) This seems to be an exact quotation as can be seen from 'iti pratijānimahe' which Kamalaśila would not have inserted had he been attempting to just state Aviddhakarṇa's argument.

(4) See Nyāya-Vārtitka, 4. 1. 21. The exact words are not found. Kamalaśila has reproduced the sense of Uddyotakara's argument, viz. "pradhāna-paramāṇukarmāṇi prāk pravṛtter buddhimat-kāraṇādhiṣṭhitāni pravartante, acetanatvād, vāsyadivat", p. 457.

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* Paper read at the All-India Oriental Conference, Jadavpur, 1969.

(5) See Nyāya-Vārttika, 4. 1. 21, where the words are very nearly the same : "buddhimat-kāraṇādhiṣṭhitam mahābhutādi vyaktaṁ sukha-duḥkhādi-nimittam bhavati rūpādimattvāt turyādivat, (p. 452),

(6) (*i*) Kṣityādi kartṛpūrvakam kāryatvāt, p. 479.

(*ii*) Parmāṇvādayo hi cetanā"yojitāh pravartante, acetanatvād vāsyadivat, p. 503.

(*iii*) dhṛteḥ khalv api-kṣitytādi-brahmāṇḍaparyantaṁ hi jagat sākṣāt param-parayā vā vidhārakaprayatnādhiṣṭhitaṁ gurutve saty apatanadharma-katvād, viyati vihaṅgamaśarīravat tatsaṁyuktadravyavac ca, p. 506; saṁharanāt khalv api: brahmāṇḍādi dvyaṇukaparyantaṁ jagat prayatnavad-vināśyaṁ vināśyatvāt pāṭyamānapaṭavat, p. 507.

(*iv*) Pada = vṛddhavyàvahāra. Yad etat paṭādinirmāṇanaipuṇyam kuvindā-dīnāṁ, vāgvyavahāras' ca vyaktavācāṁ, lipitatkramavyavahāraś ca bālānāṁ, sa sarvaḥ svantantrapuruṣaviśrānto vyavahāratvān, nipuṇa-tara – śilpinirmitāpūrvaghaṭaghaṭananaipuṇyavat, caitra – maitrādi-padavat, patrākṣaravat, pāninīyavarṇanirdeśakramavac ca, p. 508.

(*v*) pratyaya=samāśvāsaviṣaya – prāmānyam. āgamasampradāyo'yaṁ kāraṇaguṇapūrvakaḥ pramāṇatvāt, pratyakṣādivat, p. 509.

(*vi*) Śruteh – sarvajñapraṇītā vedāḥ, vedatvāt, yat punar na sarvajña-praṇitaṁ nāsau vedo yathetaravākyam, p. 509.

(*vii*) Vedavākyāni pauruṣeyaṇi vākyatvād, asmadadivākyavat, p. 511.

(*viii*) Sā (anekasaṁkhyā) apekṣābuddhijanyā, anekasaṁkhyātvāt; na cāsmadādīnām apekṣābuddhiḥ paramāṇuṣu sambhavati; tad yasyā' sau sarvajñaḥ, pp. 517–518. Nyāyakusumāñjali, Chokhamba Sanskrit Series, 1957.

(7) See – Tatra sadādayaḥ ṣaḍ aviśeṣāḥ-sad anityam dravyavat kāryaṁ kāraṇaṁ sāmānya-viśeṣavad iti dravyaguṇakarmaṇām aviśeṣāḥ, Pañjikā, 55.

(8) This is almost an exact reproduction of the words of the Nyāya-Vārttika, 1. 1. 10 (p. 68) and 3. 1. 1.

(9) This argument is found in different words in the Nyāya-varttika, 3. 1. 1 (pp. 338 ff, p. 343).

(10) See Nyāya-vārttika, 3. 1. 1. (p. 344), where the Buddhist argument of the living body being soulless is refuted.

(11) See Nyāya-vārttika, 3. 2. 14. (p. 414) from which large portions have been quoted verbatim here in the Pañjikā.

(12) See Nyāya-vārttika, 1. 1. 39.

(13) See 'Gorakhanātha and the Kānphaṭa Yogis', p. 10, George Weston Briggs (Oxford 1938).

(14) See 'Gorakhanātha and the Kānphaṭa Yogis', p. 67, G. W. Briggs.

(15) Ibid., pp. 67 ff.

(16) Ibid., p. 250.

(17) Ibid., p. 250; also pp. 239 ff.

Additional Note

Dr. A. N. Upadhye in his article on 'Some undercurrents of the Nātha-Sampradāya or The Carpaṭa Śataka' (Journal of the Oriental Institute, Baroda, Vol. XVIII, No. 3, March 1969, pp. 198 ff) has rightly pointed out that the mystico-moralists form a fraternity by themselves irrespective of their different metaphysical allegiance. Carpaṭa (–Nātha) is one of the well-recognised saints of the Nātha-sampradāya and his name is enumerated immediately after Gorakhanātha. According to some, he was a rasasiddha of some Buddhist School and later on came under the influence of Gorakhanātha; to the last he criticised laying stress on the externals only. His Carpaṭa-śataka is extant and has been printed more than once, and shows that the author was quite familiar with the Jaina tenets and ascetic congregation. Dr. A. N. Upadhye has shown that the Carpaṭa-pañjarikā-stotra ascribed to Śaṅkarācārya (788–820 A.D.) is an imitation of the Carpaṭa-śataka and borrows a great deal from the latter. Dr. A. N. Upadhye following Briggs assigns Gorakhanātha to the 10th or 11th Cent. A. D., in any way not later than 1200 A.D., and holds that Carpaṭa (–nātha) is definitely earlier than the 14th century A.D. because he is referred to in the Varṇaratnākara. Consequently Dr. A. N. Upadhye concludes that if the author of the Carpaṭa-Pañjarikā-stotra is Śaṅkarācārya, he cannot be the same as the author of the Brahma-sūtra-bhāṣya, etc., but might be some later name-sake. But we have seen that Gorakhanātha and his contemporary mystics can be assigned to the 7th or 8th century A.D., and so if the great Śaṅkara can be established to be the author of the Carpaṭa-Pañjarikā-stotra as traditionally held, there could be no difficulty in holding that he was influenced by the Carpaṭa-śataka of Carpaṭa-nātha (8th cent.), a disciple or junior contemporary or immediate follower of Gorakhanātha. This would further strengthen our conjecture regarding the date of Gorakhanātha and others on the strength of the evidence derived from Aviddhakarṇa and the references to his views.

EDWIN MUIR ON THE MYSTERY OF GOOD AND EVIL

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Edwin Muir (1887–1959) was long known as a first-rank critic and a translator of genius. His work of literary criticism "*The Structure of the Novel*" was given to the public in 1929 and is a classic of its kind. In the thirties he and Mrs. Muir jointly translated Kafka thus indirectly helping to transform the English literary scene by introducing to England one of the most influential writers of the century. Muir's recognition as a poet came late partly because he did not begin to write poetry seriously before he was thirty-five. He was made a C.B.E. after the appearance of his "*Collected Poems*" in 1952. He was appointed the Charles Eliot Norton Professor at Harvard for the year 1955–56. Other honours came—in 1957 the Russell Loines award for Poetry from the American Academy of Arts and Letters and in 1958 an Honorary Doctorate of Letters from Cambridge. Since then his reputation has steadily grown and an increasing number of serious readers are being drawn to his poetry by the rich insights and the hard-won wisdom they discover there. I came to know him when he was the warden of the Newbattle Abbey College and my memory remains fragrant with the sweetness of his personality.

Muir is pre-eminently the poet of inner life, 'the Eternal Man' in us, accessible to us in our dreams and visions, the source of our positive yearning for harmony and immortality. The intimations of this inner life made up, according of Muir, his Fable while his outer life with its day to day happenings was the story. "*The STORY and the FABLE* was the significant title he gave to the first version of his *Autobiography*. With reference to its significance Muir wrote :

"In themselves our conscious lives may not be particularly interesting. But what we are not and can never be, our fable, seems to me inconceivably interesting. I should like to write that fable, but I cannot even live it; and all I could do if I related the outward course of my life would be to show how I deviated from it; though even that is impossible; since I do not know the fable or anybody who knows it. One or two stages in it I can recognise; the age of innocence and the Fall and all the dramatic consequences which issue from the Fall. But these lie behind experience, not on its surface; they are not historical events, they are stages in the fable."

The fable, being an ideal or archetypal pattern of human life, cannot completely pass into the story, which is the sum of our conscious happenings from day to day. It is only in terms of its divergence that our story can be meaningfully related to our fable. This co-relation between the two, however, is essential; for, as Muir explains, it is only when we see the life of everyone as the endless repetition of a single pattern that we become human. "Nothing yet was ever done/Till it was done again/And no man was ever one/Except through dead men."[2] Muir was a religious man, though not a dogmatic Christian, and his conception of the story and the fable was spiritual rather than psychological. All the same it closely corresponds with Jung's collective unconscious, " where sleep the primordial images common to humanity". Many readers may wonder at the prevalence of legendary and heraldic beasts in Muir's poetry. They belong to the fabulous world of his inner life. It was Muir's belief that the fable part of his life came from the cosmic unconscious.[3] Whatever the source, the interplay of the fable and the story enabled Muir to relate the dualities of human life in meaningful pattern. Time and eternity, love and hate, good and evil, innocence and experience—all these pairs of opposites can be related to Muir's central theme: life seen in its double aspect. It was given to him more than most to enact in his own life the mythical drama of man, to live his own fable. His life and poetry are integrally related. Whatever he wrote has a poignancy and personal urgency, because it is backed by his experience and proved on the pulse. He was haunted by the existence of evil but no less by the mystery of life and sought to show "that we receive more than we can ever give; we receive it from the past, but also — and this is a point of faith — from the source of mystery itself, by means which religious people call Grace."[4] His own childhood in Orkney where he spent the first fourteen years of his life gave him his notion of the good life:

"A child could not grow up in a better place than a farm; for at the heart of the human civilisation is the byre, the barn and the midden. When my father led out the bull to serve a cow brought by one of our neighbours it was a ritual act of the tradition in which we have lived for thousands of years, possessing the obviousness of a long dream from which there is no waking. When a neighbour came to stick the pig it was a ceremony as objective as the rising and setting of the sun; and though the thought never entered his mind that without that act civilisation with its fabric of customs and ideas and faiths, could not exist—the church, the school, the council chamber, the drawing-room, the library, the city—he did it as a thing that had always been done, and done in a certain way. There was a necessity in the copulation and the killing which look away the sin, or at least, by the ritual act, transformed it into a sad, sanctioned duty.'[5]

The unitary world of his childhood soon dissolved. His father's farm broke up and family migrated to Glasgow. It was a change, not of place merely, but the telescoping of two ages set wide apart in historic time. Muir has described this change with his Scottish blend of humour and fantasy:

"I was born before the Industrial Revolution, and am now about two hundred years old. But I have skipped a hundred and fifty years of them. I was really born in 1737, and till I was fourteen no time-accidents happened to me. Then in 1751 I set out from Orkney for Glasgow. When I arrived I found that it was not 1751 but 1901, and that a hundred and fifty years had been burned up in my two days' journey. But I myself was still in 1751, and remained there for a long time. All my life since I have been trying to overhaul this invisible leeway. No wonder I am obsessed with Time."[6] Lost in the labyrinth of Glasgow he could only look back upon his Orkney life as " My childhood all a myth / Enacted in a distant isle." The Glasgow years in their immediate impact proved disastrous for the family and filled Muir, the youngest, with desolation. He lost his parents; one brother died of tuberculosis, another succumbed, after a prolonged agony, to a tumour on the brain. The remaining four members of the family went their own ways. The distresses of these years were intensified by the anguish of inner self-division in Muir. He was still preoccupied with the Calvinist doctrine of Original Sin which may have taken roots in his unconscious at an early, very impressionable age. But his heart protested against the sufferings to which the innocet lives were condemned by inherited guilt. The painful illness of his brother and four arbitrary deaths in the family posed this problem before him in its most acute form. In his vulnerable adolescence, harrowed by misery and squalor, he put up indifference as a defence. He spoke of his life in Glasgow as mostly ' sleep-walking '. He took up indifferently one job after another ending up with a nightmarish experience in a bone-factory. He might have slid down the social scale irretrievably but for his intellectual passion and something of the viking spirit of his Norse inheritance. He read widely and passionately, made friends, joined literary and discussion groups, and was a socialist before socialism became a fashion. Nietzsche's ideas of Will to Power and Superman saved him from despair of which the following lines from " Dejection " are ominous : " I do not want to be / Here, there or anywhere; / My melancholy / Folds me beyond the reach of care, ...

It was only later that Muir came to realise that his socialism and Nietzschean Supermanship were escapes from his inward unhappiness. "Thus Spake Zarathustra" strengthened him but also imprisoned him because the Will to Power was motivated by pride, not by love. Like his own Enchanted Knight, Muir's true self lay stricken under the Nietzschean rejection of sympathy and his own Puritan conscience. A Prague poem "Interceptor" throws light on this period: Asleep, awake, at work or play, / Whatever I do, wherever I go, / The Interceptor bars my way, / And to my 'Yes' says 'No'." It was this nay-sayer Muir whom Willa Anderson met and married. Muir has described his marriage as the most fortunate event in his life. "His true self lit up his eyes when I first met him," recalls Mrs Muir in her *Memoir*. This true self was now the mainspring of his life. Two other circumstaces contributed to this self-discovery : a course of psycho-analysis and his friendship with Holms. Psycho-analysis opened up the narrow passage to the collective unconscious, a boundless expanse free from inner contradictions[7], access to which had been blocked by the repressed material of his earlier painful years. Holms was a genius, not a personality. By his uninhibited reactions to poetic stimuli he encouraged Muir to study poets like Wordsworth, Vaughan and Traherne and revived Muir's faith in his childhood visions, Muir is very clear on the nature of this spiritual liberation : "I realised I must live over again the years I had lived wrongly. Till now I realised that I had been stubbornly staring away from myself—as incapable as Time of turning my head and seeing what was behind me. I had been existing merely as something which consisted of the words with which one tries to explain it; so that when at last I looked back at that life which, whatever I might think of it, was the life I knew best it seemed to me that I was not seeing my own life merely, but all human life, and I became conscious of it as a strange and unique process. In turning my head and looking against the direction in which Time was hurrying me I won a liberation and a new kind of experience; for now that I no longer marched in step with Time I could see life timelessly and with that in terms of the imagination." [8]

Surprisingly it was during the anxiety-ridden war years that Muir wrote some touchingly serene poems on the subject of self-discovery. One of these "The Question" suggests that the seeker who has sought so long will "Catch sight some ordinary month or week / of that strange quarry you scarcely thought you sought / Yourself, the gatherer gathered, the finder found / The buyer, who would buy all, in bounty bought– / And perch in pride on the princely hand, at home, / And there the long hunt over, rest and roam." The word 'home' is a reminder of Muir's happy married life keeping a vacant gate "Where order and right and hope and peace can enter." [9] Muir has written some beautiful love poems addressed to his wife either directly or indirectly through Greek myths. Their singular beauty is all the more remarkable when we remember that they were written at over fifty and after more than twenty years of marriage. In these he celebrates the unearthly felicity of love's fulfilment which haunts our dreams and the inadequacies of the human response, [10] the sense of belonging which yet keeps inviolate the individual identity, [11] A little paradise / Held in the world's vice." [12]

Muir's later development is largely the story of his poetic pilgrimage back to Innocence ("The Journey Back") to recover that unity of being which is possessed in chilhood but which is lost by man's fall into the contradictions of his later years. Muir's own crisis seems to recapitulate this fall. He had known in Glasgow the horror and boredom of life without its glory. His prolonged stay in Europe brought home to him the crisis in Western civilisation which culminated in the disastrous world war. In the twenties he lived in Germany, Austria and Czechoslovakia, already overcast by the shadows of coming events. After the war he was back in Prague when the Communists seized power (1948). He saw how through the indifference and betrayal of their fellow-men a whole people was reduced to a nameless and homeless existence.[13] In the thirties his *Scottish Journey* took him through a country impoverished by religious fanaticism and economic exploitation.[14] Both by his personal distresses and common disasters Muir was deeply committed to the human situation. The need for the revival of his childhood memories was, therefore, no nostalgic yearning nor an emotional regression. In his poem "The Return" he describes himself as time's true servant. The past he knew, is beyond recall and it leaves nothing behind but infinite longing. Nietzsche's doctrine of eternal recurrence offered a refutation of time but he rejects it as nugatory of all human values : "And the heart and the mind know / What has been can never return, / What is not will surely be / In the changed unchanging reign, / Else the Actor on the Tree / Would loll at ease, miming pain, / And counterfeit mortality."[15]

We cannot deny reality to our experience in time nor disown responsibility of adult life. The journey back to Innocence, the archetypal form of wholeness, can only be retraced along the razor's edge of experience. Only imagination could unite all experience, past and present, serious and trivial. The redemption of time through spiritual recovery is brought about not by conscious contriving but by an act of grace. The later poetry of Muir is pervaded by the theme of reconciliation of time and eternity, fall and innocence, necessity and freedom, spirit and flesh. Time is no longer, as in earlier verse, an evil and unpity-ing force. In love, born in a time and place, soul and body act together "To make us each for each / And in our spirit whole." [16]

In the mystery of Incarnation, the supernatural enters time, heaven and earth are joined, and time and eternity are reconciled [17] In this life-affirming and earth-accepting vision everything is seen in sacral relationship, binding the whole of creation under the mysterious covenant or the Biblical Brith.

"The covenant of god and animal, / The frieze of fabulous creatures winged and crowned, / And in the midst the woman and man-Lost long ago in the fields beyond the Fall– / Keep faith in sleep–walled night and there are found / On our long journey back where we began."[18]

Muir held in horror all absolutes and the categories of reality according to which the impatient idealists and the eternal rebels would have the world remoulded nearer to their heart's desire. "Song for a Hypothetical Age" is a kind of rifacimento of the chapter "Rebellion" in *The Brothers Karamazov* of Dostoevsky. Ivan the romantic nihilist cannot accept or forgive a world which involves innocent and unavenged suffering. Against an impersonal order founded on abstract justice and autotelic art Muir stakes the claims of life and humanity.

"Idle justice sits alone / In a world to order grown / Justice never shed a tear, / And if justice we would bear / We must get another face, / Find a smoother tale to tell / Where everythings is in its place / And happiness inevitable.[19]

In opposition to the historical view of Oswald Spengler he accepts the religious view according to which moral struggle is a necessary process of spiritual rebirth without which the natural man cannot become human in the complete sense.[20]

As an example of Muir's power to illuminate a spiritual paradox inherent in man's ordinary existence take his poem "The Good Man in Hell". He uses the terms 'heaven' and 'hell' to describe only the extreme froms of our life on earth. The tone of the poem is quietly reflective, tentative and hypothetical. "If a good man were housed in Hell," would he surrender to obvious hate or would he at last grown patient kindle a hope in hopeless Hell? It concludes on the power of good.

"One doubt of evil would bring down such a grace, / Open such a gate, Eden would enter in, / Hell be a place like any other place, / And love and hate and life and death begin." The resolution of the poem is still tentatively framed but this only serves to reinforce the actuality of the human situation. Kafka a twin soul has the following reflection :

"The crows maintain that a single crow could destroy the heavens, There is no doubt of that, but it proves nothing against the heavens, for heaven, simply means: the impossibility of crows."

Muir's poem is a restatement of the truth that the good man in hell simply means the impossibility of hell and the possibility of the human world in which good is always mysteriously active and operative to annul evil. There was a mystic strain in Muir which was powerfully reinforced by his readings of Boehme, Dante, Dostoevsky and Kafka. He quotes with approval Boehme's statement on the problem of evil: "Reason says that because man was found dis-obedient God cast his fierce anger upon him. Thou must not think such thought. For God is love and goodness and there is not an angry thought in Him. It was man who should never have punished himself." Compare the exhortation of Father Zossima in *The Brothers Karamazov*: "What is hell? I maintain that it is the suffering of being unable to love."[21] Or take this reflection of Kafka: "We are sinful not only because we have eaten of the Tree of Knowledge but also because we have not yet eaten of the Tree of Life." What Muir thought of evil may be gathered from his talk on "The Devil in Literature" which he gave to his class during my stay at the Newbattle (1952). Tracing the primitive conception of evil to its root in fear he uncovered the different disguises assumed by this embodiment of evil in literature and he regarded Dante's Devil as the profoundest of the lot: for Dante's Devil embodies the spirit of betrayal. The greatest sin is sin against oneself, what turns us away from our essential nature.

Muir's final statement of his faith in his last book of verse "One Foot in Eden" (1956) makes a closer approach to Christian philosophy than before. He held that human nature remains good in its very essence, that such a basic goodness joined to a swarming multitude of particular evils is the very mystery and the very motive power of struggle and progression in mankind. The key idea is the transfiguration of reality by love, human and divine. The emphasis falls on the acceptance of the totality of human experience. Whatever their theological implications, the Fall and Eden are the archetypes of human experience. In the title poem one foot is firmly on earth. The poem celebrates the qualities which make life human. Its heraldic imagery of armorial weed, archetypal leaf and famished field suggests the eternal pattern of human life. " The corn and tares compactly grown " recall Milton's Areopagitica but Muir's poem conveys its meaning through the intensity of its texture and has a depth and dignity which Milton's too easy an approach to the subject did not attain. In Muir we seen to be listening to our own heart-whispers. His verse taps the submerged treasuries of mankind's common dream. The language itself is natural because great themes, he held, have to be stated clearly. But naturalness, he also reminds us, does not come easily to the awkward human race and is an achievement of art.[22]

One Foot in Eden[23]

One foot in Eden still, I stand/And look across, the other land./The world's great day is growing late,/Yet strange these fields that we have planted/So long with crops of love and hate./Time's handiworks by time are haunted,/And nothing now can separate/The corns and tares compactly grown./The armorial weed in stillness bound/About the stalk; these are our own./Evil and good stand thick around/In the fields of charity and sin/Where we shall lead our harvest in./Yet still from Eden springs the root/As clean as on the starting day./Time takes the foliage and the fruit/And burns the archetypal leaf/To shapes of terror and of grief/Scattered along the winter way./But famished field and blackened tree/Bear flowers in Eden never known./Blossoms of grief and charity/Bloom in these darkened fields alone./What had Eden ever to say/Of hope and faith and pity and love/Until was buried all its day/And memory found its treasure trove?/Strange blessings never in paradise/Fall from these, beclouded skies.

Muir claimed no uniqueness for his experience. He closes his *Autobiography* with the following thought :

> " I think that if any of us examines his life, he will find that most good has come to him from a few loyalties and a few discoveries made many generations before he was born which must always be made anew."[24]

This conclusion is characteristic of a poet whose integrity of purpose, as Stephen Spender notes,[25] converted his life into a spiritual pilgrimage. He lay no Eliot-like stress on religious dogma nor did he feel the need for any such occult and metaphysical system as that of Yeats. On the road to self-knowledge he derived guidance from many sources. " I have been taught" is the last poem of his Collected Verse (1960). It affirms in terms of acceptance and gratitude the mystery alike of his life and art :

> "And now that time grows shorter, I percieve
> That Plato's is the truest poetry,
> And that these shadows
> Are cast by the true."[26]

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THE PROBLEM OF GUṆĪBHŪTAVAṄGYA KĀVYA
OR
POETRY OF SUBORDINATED SUGGESTION*

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' Summary '

Aesthetes of poetic art, when they enjoy poetry or literature, undergo an experience of supreme joy. Normally a piece, taken as a whole, as an indivisible organic unity, creates a particular response in the heart of a connoisseur. But when a second thought is given to the particular literary piece or poem, in moments of tranquility, the critic is in a position to discern different modes of appeal which may be held to be responsible for this or that type of classification of poetry - (apoddhārabuddhyā vibhajyate - abhinava).

Sanskrit poeticists headed by Ānanda have advanced a three - fold scheme of classification of poetry. With reference to the suggested sense being the principal or subordinate source of charm in poetry, poetry is called either as ' dhvani kāvya ' or suggestive poetry, or guṇībhūtavyaṅgya i.e. poetry with subordinated suggestion, etc.

In this small article, we will try to discuss the nature and scope of what is termed as guṇī. or poetry with subordinated suggestion. We will try to consider how Ānanda treats and elaborates the topic and then how later Ālaṃkārikas build a grand edifice on what Ānanda has done.

We will go to observe, that in the Dhv. there is no clear line of demarcation between dhvani and guni. in the sense that some illustrations of the latter also fall under the former when viewed from a particular angle and vice versa, and that the sub-divisions of the latter are also less systematic. Probably Ānanda was not seriously inclined to establish any water-

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tight divisions and sub-divisions of poetry. Poetry for him, seems to be a living organism, incapable of being twisted in exactly this or that particular mould. Mammata offers a comparatively more systematic scheme. Hemaçandra is precise and clear, and particularly so, when he shows less enthusiasm regarding the tendency of hair-splitting so common to the Indian poeticists in general. Jagannātha strikes a different note.

As observed earlier, different modes of appeal in poetry give rise, among Sanskrit critics of poetry to the tendency to classify poetry into this or that type and then to give divisions and sub-divisions which become more or less pedantic and mechanical. Even Ānanda is not completely free from this and later critics become greater pray to this tendency. Ānanda was perhaps wiser in not naming the three types as 'Uttama' or excellent, 'madhyama' or mediocre, and 'adhama' or low type of poetry, which Mammaṭa does. All this is critically examined in the small article.

—T. S. Nandi.

Aesthetes of poetic art, when they enjoy poetry or literature, undergo an experience of supreme joy. A particular poem or piece of poetry makes an appeal to their heart and they are moved by it. Normally the piece, taken as a whole, as an indivisible organic unity, creates a particular response in the heart of the connoisseur. But when a second thought is given to a particular poem, in moments of tranqility, the critic is in a position to discern different modes of appeal. These different modes can be held to be responsible for this or that type of classification of poetry in the hands of Sanskrit Poeticists. Ālamkārikas headed by Ānanda, have classified poetry into dhvanikāvya or suggestive poetry with its suggested sense being the principal source of charm, guṇibhūtavyangya or poetry with subordinated suggestion i.e. one in which the suggested sense subserves and enhances the charm of the expressed sense, and citrakāvya or one in which only the expressed sense becomes the source of charm, if any. Ānanda, as we will go to observe, and also Abhinava, seem to hold that even the so called guṇi· or poetry with subordinated suggestion also can be taken as dhvanikāvya or suggestive poetry, when viewed from a particular point of view. Thus, in a way, they seem to reject the idea of a watertight classification of poetry and probably from this point of view also, Ānanda wisely avoids naming this or that type as 'uttama' or excellent, 'madhyama' or modiocre, and 'avara' or low type of poetry. Poetry, if at all it creates any response in the heart of a connoisseur, does it only when taken as a single effort of the poet, one and indivisible, a complex unity. However, in moments of tranquility or rest, the faculty of subtle analysis starts operating and it divines out different modes of appeal in poetry. Probably this gives rise to the broad form of three-fold classification as above. Divisions and sub-divisions of this or that type of poetry can simply be dubbed as can instinct for hairsplitting so peculiar to the Indian mind in general. We may take illustrations of the three types of poetry before we come down to the particular variety called the guṇī.

The dhvanikavya or suggestive poetry is one in which the suggested sense, particularly of the form of rasa or sentiment becomes the principle source of charm. Thus, e.g. in,

S'ūnyaṃ Vāsagṛhaṃ vilokya śayanādutthāya kiṃcit S'anaiḥ...... ....etc.1

"Seeing the sleeping chamber secluded,
The young wife gently rose a bit from her tridal bed,
And went on feasting her eyes for long,
On the face of her husband feigning sleep;
She then kissed his face without hesitation
And finding that his cheeks were thrilled at her kiss,
She bent down her head abashed.

Then it was that the laughing husband kissed her long in turn."

(Trans. K. Kri.)

Sanskrit poeticists feel that the source of poetic appeal lies in its suggestion of the sentiment of love or sṛṅgāra. While in yet another poem, viz.–

Anurāgavati saṃdhyā divasaḥ tatpurassaraḥ ।
Aho daivagatiḥ kīdṛk tathāpi na samāgamaḥ ॥
" Twilight is full of love (also, red colour),
And the day is moving in her front,
But oh, look at decree of Fate
The twain do never meet ! "
(Trans. K. Kri. Dhv. p. II)

the expressed sense i.e. the bare description of sunset by itself is very touching to a responsive heart.

However, the aesthete also feels an under-current of suggested sense in which there is a faint realisation of the fact of a loving lady, with her heart full of love, trying to pursue an unyielding hero. This undertone enhances the beauty of the expressed sense in form of a lovely description of sunset. Yet another variety of poetry is taken notice of by Sanskrit Poeticists. It is that type in which there is no under-current of a subordinated suggested sense, causing any further charm. This is illustrated as in :–

Vinirgataṃ mānadamāmandirāt
Bhavatyupaśrutya yadṛcchayāpi yaṃ /
Sasaṃbhramendradruta pātitārgalā
Nimīlitākṣīva bhiyāmarāvatīl ॥

Amarāvatī,—when its latch was swiftly swang down by Indra in confusion, on hearing that he, (Hayagriva) the subduer of the pride (of enemies) had energed, though by chance, from his palace,—appeared to close her eyes in panic. (Translation–Sukthankar) (K. P.)

Herein, the bare description of Amarāvati provides charm.

Thus we see that an effort in analysing poetic experience gives rise, into the hands of Sanskrit poeticists, a threefold classification of poetry.

In this small article we will try to discuss the nature and scope of what is termed as guṇi. kāvya or poetry with subordinated suggested sense. We will try to consider how Ānanda treats and elaborates the topic and then how later ālaṃkāriks build a grand edifice on what Ānanda has done. It should be noted however, that we do not come across the same classification as above, in the works of earlier poeticists such as Bhāmaha, Daṇḍin, Vāmana, etc.[1]

In the Dhvanyāloka, Ānanda, discusses the nature and scope of what he called Dhvanikāvya or suggestive poetry having the suggested sense as the principal source of charm and the expressed sense being sub-servient to it, with all its varieties and sub-varieties, up to udyota III. Kārikā 33. He concludes the discussion with the words :– "The variety of poetry designated as suggestion which had become a source of controversy for long, because its real nature had eluded even persons of the best intellect, has now been explained in this way."[2] Ānanda, then comes to the second variety of poetry called 'guṇībhūtavyaṅgya' or poetry with subordinated suggested sense. He says : (Dhv. III, 35) : "We can see another variety of poetry viz. poetry of subordinated suggestion, where in the artistic excellence of the expressed is greater than that of the suggested, though the latter also happens to be present alongside of the former".[3] Ānanda adds that when the suggested sense which is compared to the charm of a damsel is predominant in poetry, it is said to be 'dhvani'. And when it is rendered subservient and in itself lends charm to the expressed sense, it is said to be poetry with subordinated suggested sense.

Ānanda then tries to give some further varieties of this type of poetry. We have seen elsewhere that fundamentally dhvanikāvya is sub-divided into one in which the power of suggestion or vyañjanā is based on abhidhā or the power of expression and the other in which vyañjanā or the power of suggestion operates through lakṣaṇā or indication. In the same way, Ānanda says, that the first variety of guṇī. is obtained when a bare idea conveyed by such works as have lost their conventional denotation might be the suggested element and it might become subservient to the expressed sense. Thus this is the case of 'atyantatiraskṛtavāçyarūpa vyaṅgya' which is of the form of 'vastu' or idea being sub-ordinated to the expressed sense.[4]–e.g. :

> Lāvaṇyasindhuraparaiva hi keyamatra
> Yatrotpalāni śaśinā saha saṃplavante /
> Unmajjati dviradakumbhataṭī ca yatra
> Yatrāpare kadalikāṇḍamṛṇāladaṇḍāḥ //[5]

By the word 'sindhu' or ocean is suggested fullness; by 'utpala', the side–glances of the eyes; by śaśi, the face; by dviradakumbhataṭī the two breasts; by kadalikāṇḍa the two thighs etc. are suggested. The primary meaning of these terms is brushed aside (atyantatiraskṛta) and the secondary sense is resorted to, which helps the suggestion of the vyaṅgya or the suggested sense, which ultimately becomes subservient and renders charm to the expressed sense.

Second variety of this type of poetry arises when words with their expressed sense not concealed (atiraskṛta) give rise to a suggested sense which is subordinated to the whole expressed sense of the sentence.[6]

The illustration is :

> Anurāgavatī saṃdhyā divasaḥ tatpurassaraḥ /
> Aho daivagatiḥ kīdṛk tathāpi na samāgamaḥ //[7]

Third variety occurs when the vyaṅgya or the suggested sense is subordinated by its own expression through some other words[8] The illustration is :–

> Saṅketakālamanasaṃ viṭam jñātvā vidagdhayā /
> Hasannetrārptākūtaṃ līlāpadmaṃ nimīlitam //[9]

It may be noted that this variety depends more on the mode of conveying the suggested sense, rather than the type of suggested sense itself.

The fourth variety occurs when suggested sense in form of sentiment and the like is subordinated to another principal rasa or sentiment and the like. Actually this is the field of alaṃkāras such as rasavat and the like.[10] It may be noted that in this particular variety; illustrated by the stalk illustration viz. ayaṃ sa rasanotkarṣī......etc., we find that the fields of rasavadādi alamkāras and guṇī. kāvya merge into each other.

Ānanda does not attempt to draw a clearcut line demarcating the spheres of both. We will observe later on that Mammaṭa also fails to do the same, while it is only in Jagannātha that we find a clear line of demarcation laid between the fields of dhvani, guṇi. and alaṃkāras.

Fifth variety occurs when a suggested figure is subordinated as in case of dipaka and the like. On finding out the charm of the above mentioned fifth variety, Ānanda becomes so jubilant that he declares: " The whole host of figures is seen in many instance to put on a new charm when it is brought into touch with the suggested element. " And adds, " The earlier writers on poetics have themselves shown how a few of the figures of sense acquires a new charm when they get into touch with the suggested element consisting of either a figure or a bare idea. But a scrutiny of instances will reveal that this is true of all the figures."[11] Ānanda says that as in the case of dīpaka and samāsokti, other alaṃkāras also seem to be containing the touch of another figure or another idea. For example, the touch of the figure atis'ayokti can be said to be there in case of practically all the other figures of speech. Bhāmaha has also said as such. Other alaṃkāras also follow the suit, though they cannot be seen to be contained in all the rest as is the case with atis'ayokti. Ānanda points out that in some figures, the said scope is limited to suggestion of certain figures only. e g. preyas is invariably seen in vyājastuti, and the like. In other figures, the said scope is further limited to suggestion of figures only, as against ideas, e.g. there is upamā in saṃdeha and the like. Yet other figures are found to be mutually involved, e.g. dīpaka and upamā. Ānanda then declares that–"All figures, then, which contain a touch of suggestion at the same time owe their excessive charm due to that touch, deserve to be brought within the compass of poetry of subordinated suggestion. "[12] He adds: " Therefore, this second manifestation of suggestion too should be recognised by cultured critics as a beautiful avenue for master poets. Certainly, there is not a single variety fo poetry holding out an appeal to the heart of cultured critics which does not attain artistic excellence by the slightest touch of suggested sense. The learned should deem this as the greatest secret of poetry.[13]

Sixth variety of guṇī. or poetry of subordinated suggestion arises when another sense is suggested with the help of kāku or intonation, e.g. in svasthā bhavanti mayi jīvati dhārtrarāṣṭrāḥ . . . . etc.[14]

Ānanda holds that instances which can reasonably be brought under this class of poetry should not be classed under Dhvani by cultured critics.[15]. For instance, in 'patyuh śiras'candrakalāmanena'..etc., the suggested sense seems to be subordinated by the expression viz. 'nirvacanaṃ jaghāna'. So, this should fall under guṇī. kāvya and not dhvani kāvya.

Ānanda then seems to wind up the discussion with the remark that, "*This class of poetry*, viz. that with subordinated suggestion, *will also assume the form of Dhvani* or that with principal suggestion if one views it from the standpoint of exclusive purport of sentiment, etc."[16] Thus it seems that from Ānanda's point of view, one and the same illustration can serve for both dhvani and guṇī. types of poetry, when viewed from different angles. This position, however, seems to be a little bit confusing and we miss a clear line of demarcation between these two types of poetry. Or perhaps Ānanda did not wish that such water-tight compartments be imagined in case of poetry which refuses to be enclosed in just this or that groove. Any way, we have to wait for Jagannātha for a completely clear, distinct and well-defined idea of the two. However, we will go to see that he too gives rise to some other problem.

Thus we see, that in Ānanda we come across only six clear sub-divisions, though he has suggested innumerable sub-varieties on accout of the infinite variety of the suggested sense. Out of the six, one consists of rasavadādi alamkāra. First two varieties are based on the suggestion of an idea based on either abhidhā or the primary function of a word or lakṣaṇā, the power or indication, i.e. the secondary function of word.

One variety depends on the subordinated alamkāra-suggestion. The rest depend, as noted earlier, more on the mode of conveying the subordinated suggested sense; one on the faulty way of conveying and the other on conveying through intonation (kāku).

Abhinavagupta's attitude in this respect is quite characteristic of his general approach to poetry. For him, as noted at many places in his Locana, both vastudhvani and alaṃkāradhvani ultimately terminate into rasa-dhvani and virtually this alone is the soul of poetry. So, in all the vorieties of guṇi. according to Abhinava, what happens is that first of all some suggested sense is subordinated to some expressed sense which in its turn ultimately terminates into some other rasavyañjanā. Thus for him all guṇī. is ultimately nothing else but dhvani kāvya itself.[17]

In Mammaṭa, however, we come across a more systematic classification and division. He defines guṇī or poetry with subordinated suggestion in the words:– when the suggested sense is not similar to that (i.e. not principal) (we have) guṇi, (and it is) mediocre (Poetry).[18] He explains that by 'atādṛśi' or not similar to that is meant that sort of suggested sense which is not more charming than the expressed sense.

Mammaṭa starts the *V*th ullāsa with an eight-fold division of guṇi. He mentions the following varieties; aghūḍha, aparāṅgabhūta, vācyasiddhyaṅga, asphuṭa, sandigdhaprādhānya, tulyaprādhānya, kākvākṣipta, and asundara. As noted above, he calls this type of poetry to be 'madhyama' or mediocre, 'dhvani' being 'uttama' or excellent, and 'citra' being 'adhama' or low-class poetry. This sort of naming is not to be met with in Ānanda, though he very much implies it.

He introduces the first sub-varitety viz. 'aghūḍha' with the words that whatever is concealed like the breasts of a woman, becomes a source of charm, while that which is not concealed, on account of its being clearly revealed, becomes as it were like the expressed. Thus 'aghūḍha' is almost like the expressed. The illustration is: yasyāsuhṛt kṛta tiraskṛti..etc. wherein the word 'Jivan' has a suggested sense based on indication or lakṣaṇā with the arthāntarasaṃkramitavācya. The word 'Jivan' or 'living' loses its original sense and acquires the sense of 'hated existence'. Yet another illustration is supplied which is based on atyantatiraskṛtavācya dhvani being subordinated. In this illustration the word 'cumbi' means 'touching' and not 'kissing'. In both these illustrations the suggestion which is subordinated is itself 'aghūḍha' or not concealed and therefore not a source of any charm. So, we may say that this variety depends not only on the formal classification of dhvani, but also on the mode of conveying that particular dhvani or suggestion. Third illustration viz. atrāsit..etc., also gives 'aghūḍha' variety in which resonant like suggestion based on the power of sense (arthaśaktimūlānuraṇanarūpa) is subordinated to the expressed sense.

In Aparāṅgabhūta variety, Mammaṭa incorporates all the alaṃkāras that fall in the rasavadādi class. This may be taken as an advance on Ānanda who seems to take them as both 'alaṃkāra' and 'guṇi'.

Mammaṭa also extends the scope of this variety, when he herein incorporates the subordinated sense of the type of suggested figure based on the power of the word i.e. S'abdaśaktimūla alaṃkāradhvani. The next illustration is for the saṃlakṣyakrama vastu dhvani being subordinated (vācyāṅga) to the expressed sense. The former is illustrated by the verse, janasthāne bhrāntaṃ ..etc., in which the suggested figure upama based on the power of word becomes subservient to the expressed element mentioned through the words viz. mayāptaṃ rāmatvam. The latter is illustated by the verse viz. āgatya samprati..etc., in which the behaviour of the hero which is suggested, rests on the expressed sense viz. the behaviour of the sun and the lotus plant.

Thus, we have in all ten illustrations of this variety, eight of which are concerned with subordinated rasādi dhvani or the suggestion of sentiment and the like, and the last two are concerned with subordinated alaṃkāradhvani and vastudhvani, respectively.

The difference between the second and the third varieties of the guṇi. or poetry with subordinated suggested sense, should be noted. The second variety, viz. 'Vācyāṅga' and the third variety, viz. 'vācyasiddhyaṅga' differ in the fact that while in the former the suggested sense becomes subordinated to an expressed sense which is complete in itself and does not stand in need (i.e. nirapekṣa) of the support of the suggested sense, in the latter, on the other hand, the expressed remains incomplete till it gets the support of the suggested sense.

'Vācyasiddhyaṅga' is illustrated by two verses. In the verse, viz. bramiṃ aratiṃ, etc. the suggested sense in form of 'hā'āhala' or poison, i.e. the suggestion of a bare fact or an idea, 'vastu', is subservient to the expressed sense in form of a serpent.

The fourth variety viz. 'asphuṭa' can be contrasted with the first one. While in the first variety viz. aghūḍha, the fault lies in the suggested sence being not properly concealed, in this variety the fault lies in the fact of its being too much concealed. The illustration is : a dṛṣṭe dars'anotkaṇṭā .... etc., in which the subordinated suggested sense is too much concealed.[19] This variety also can be said to depend not as much on the nature of the suggested sense, as on the faulty mode of conveying the suggested sense, as in case of the first variety. This is so with reference to the following three also.

In the saṃdigdhaprādhānya variety, there is, as the name suggests, a doubt as to the preponderance of either the suggested sense or the expressed sense; e.g. in the verse, viz. harastu kiṃcit parivṛttadhairyaḥ, etc. the suggested sense in form of the desire to kiss and the expressed sense in form of the directing of eyes, seem to be equally powerful.[20]

Tulyaprādhānya, the sixth variety occurs when the suggested sense and the expressed sense carry equal weight. The illustration is : 'brāhmaṇātikramatyāgo bhavatāmeva bhūtaye.. etc. In this verse, the suggested sense, viz. that Jāmadajñya will destroy all the demons in the same way as he destroyed the kṣatriyas, is equally powerful.[21]

The seventh variety is one based on the subordinated suggested sense depending on intonation, i.e. kāku. The illustration is, 'mathnāmi kauravas'atam '. . . .etc. Herein, the suggested sense viz. that, 'I will kill ', stands with the negation of the expressed sense.[22]

The eighth variety, called 'asundara ' depends, as is implied by the name, on the indecent suggested content. Thus we come across a fresh principle of morality and the like. The illustration is : vāṇirakuṃangu . . . . etc. The idea is that some paramour who was given appointment has entered the bower, and through this suggested fact the expressed fact, viz. that of the house-wife feeling nervous, is rendered more charming.[23]

Mammṭa further goes into the sub-divisions of guṇī He says that the sub-divisions of this type of poetry should be understood as those in case of the dhvaní-kāvya or poetry with the suggested sense as the principal one.[24]. He adds that by the word 'yathāyogam ' or 'accordingly ' is meant that according to the statement of Ānanda, viz. 'that when alaṃkaras are suggested by vastu or idea, these form portions of 'dhvani ', for poetry rests on that, when an alaṃkāra is suggested by vastu or idea, the suggested alaṃkāra is always to be taken as principal. It is never subordinated to the expressed sense. Thus, instead of the fifty-one principal sub-divisions of dhvani or suggestive poetry, we have only 42 principal sub-divisions of guṇī. or poetry with subordinated suggestion. The alaṃkāra, suggested by the three-fold vastu or idea, viz. svatahsaṃbhavi, kavipraudhoktisiddha and kavinibaddha vaktṛpraudhoktisiddha, which again is three fold each, viz. padagata, vākyagata and prabandhagata,–is never subordinated to the expressed sense and thus does not give rise to the guṇī. variety of poetry. Mammṭa further adds that by saṃsṛṣṭi and saṃkara with the other subdivisions of dhvani and alaṃkāra, the total mounts to a very great extent.[25]

Thus, it seems that Mammaṭa has tried to treat the problem in a more systematic way as compared to Ānand.

Hemçandra, in a style so characteristic to him, reduces the divisions and sub-divisions and accepts fundamentally only three varieties of guni. which he styles as ' madhyama ' following Mammaṭa. He says : " When (the suggested sense) is not (principal), when the predominance is doubtful or equal, ' madhyama ' is three fold.[26], ' asatprādhānya ' i.e. absence of predominance of the suggested sense at times arises out of is being not more charming than the expressed sense e.g. vānira kuḍam .. etc., or at times, it is due to the suggested sense being the part of the expressed (paraṅgatvena), as in case of ' ayaṃ sa raśanotkarṣi....etc.'[27] At times the suggested sense becomes subservient to the expressed through asphuṭatva or atisphuṭatva. Hemcandra includes kākvākṣipta variety under ' tulyaprādhānya.' It may be noted that Hemaçandra's treatment is even more precise and systematic as compared to his masters.

Vis'vanātha closesly follows Mammṭa and Ānandavardhana in defining the guṇi. and giving the principal eight sub-divisions He also quotes Ānand and says that when the suggested vastu (idea), alaṃkāra (figure) or rasa (sentiment) is subordinated to some other principal rasa, this should be recognised as a dhvani kāvya or suggestive poetry and not guṇi. or poetry with subordinated suggestion.[28] This, in a way, may be taken as an advance over Ānanda in the sense that while Ānand is inclined to give two names to one and the same piece of poetry when viewed from different points of view, Vis'vanātha makes up his mind and calls such poetry to be ' dhvani ' only and not guṇi. He further quotes the opinion of Caṇḍidāsa who seems to hold that when one enjoys poetry, the experience is total in itself and is grasped by akhaṇḍa buddhi i.e. undivided mind, i.e. by the whole of the psyche. Only at a later stage, when one thinks of the context and the like, one realises the difference in type such as dhvani, or guṇī., etc., and eventhough this difference downs upon one's mind at a later stage, one's former experience is not retarded, for it rests solely on taste.[29] This may be compared to, what in modern literary criticism is said to be 'holistic view' of poetry.

Jagannātha offers a four-fold scheme of division of poetry in which he mentions uttamottama, uttama, madhyama and adhama. What we recognise as guṇī or poetry with subordinated suggestion is taken by him as 'uttama', which he defines as; 'that in which the suggested sense necessarily being subservient, yet becomes the source of charm' [30]. He further adds that the 'evakāra' or emphasis in the definition is there to exclude such instances of poetry in which the suggested sense is at least principal (pradhāna) with reference to the expressed sense (vācya) but is rendered subordinate to yet another suggested sense.[31] Such instances e.g. ayam sa rasanotkarṣī, etc. should be taken as uttamottama i.e. dhvani-kāvya only. There should be no difference of opinion about this. We have seen earlier that Ānanda and Mammaṭa take this particular instance as guni. from the point of view of subordinated śṛṅgāra while from the point of view of karuṇa, it is an instance of 'dhvani' kāvya for them. Jagannātha discourages such double standards being applied to one and the same piece of poetry. He further adds that by the use of the word 'camatkāra' or charm in the definition, he excludes instances of what may be called līna or too much concealed suggestion, and also of 'vācyacitra' or poetry with the figures of word, and sense as the only source of charm i.e. 'adhama kāvya'. Jagannātha maintains that while in both viz. uttamottama variety and uttama variety, vaṅgya or the suggested sense becomes the source of charm, yet there is a difference between the two brought about by the fact of the suggested sense being principal or subordinate. He also goes to include certain figures such as samāsokti, paryāyokta, etc., into 'uttama' veriety because the source of charm lies in the subordinated suggestion and not the expressed sense. Thus there is a distinction between a figure and a figure. Eventhough all the figures have some implicit element in them, as noted by Ānanda earlier, all cannot be included in this variety. This sort of a clear perception of the difference in the source of charm, and therefore a clear line of demarcation between dhvani or uttamottama, guni. or uttama, arthālaṅkāras or madhyama and citra may be taken as an original contribution of Jagannatha, for even Ānanda and Mammaṭa have not perceived this.

Thus we have seen that in Ānanda there is no clear line of demarcation between dhvani, guni., and artha-chitra, and the sub-divisions of guni. also are less systematic. Probably he was not seriously inclined to establish any watertight divisions and sub-divisions of poetry. Mammaṭa has a comparatively more systematic approach. Hemaçandra is clear and precise and particularly so when he shows less enthusiasm regarding the tendency of hair-splitting so common to the Indian poeticists in general. But he too, seems to echo the opinion of his masters, Ānanda and Mammta, in case of the particular instance, viz. ayam sa..etc., and takes it is aparāṅgabhūta vyaṅgya. Vis'vanātha repeats Ānanda's observation, yet he shows his inclination towards taking such instances as 'uttama' kāvya.[32] Jagannātha, as already observed, strikes a different note.

Conclusion: As seen above, different modes of appeal in poetry give rise, among sanskrit critics of poetry, to the tendency to classify poetry into this or that type and then to give divisions and sub-divisions which become more or less pedantic and mechanical. Even Ānanda is not completely free from this lure of giving mechanical multiplications. But later critics become greater pray to this tendency. Āṇanda, it seems, was wiser when he did not name the three types a uttama or excellent, madhyama or mediocre, and adhma or low type, which Mammaṭa does. Hemaçandra shows some descretion in cutting down the number of these mechanical divisions and sub-divisions, which later critics, including Jagannātha seem to revive with greater force.

It may be noted that Ānanda is inclined to be more charitable when he shows his preparedness to accept one and the same illustration as both dhvani and gunī. and thereby to indicate the fluid and complex nature of poetry. If we find some discrepancy in this, it is tolerable, for he errs on the sufer side by allowing a wider scope to poetry. Jagannātha, when he tries to be more systematic in order to avoid the above mentioned contingency of calling one and the same piece of poetry as both dhvani and gunī., falls into yet another trap. As already seen, for him, both in the uttamottama variety and uttama variety, vyaṅgya or the suggested sense becomes the source of charm, yet there is a difference between the two brought about by the fact of the suggested sense being principal or subordinate. However, we know that in poetry, a particular sense is called principal or subordinate only from the point of view of its capacity to become a source of charm. So his definition of uttama as: 'that in which the suggested sense necessarily being subservient, yet becomes the source of charm', seems to involve some contradiction, in as much as it is called subservient only because it is a lesser source of charm. It cannot be the only source of charm, much less, the principal.

Foot-notes

(1) भामह— I. 16–18, दण्डिन् I 11–13, वामन I. 3.21–22;

(2) Dhv. III. 34 : विमतिविषयो य आसीन्मनीषिणां सततमविदितसतत्त्वः ।
ध्वनिसंज्ञितः प्रकारः काव्यस्य व्यञ्जितः सोऽयम् ॥

(*Note.*—The transtation of the kārikās and text of the Dhv. quoted in this article follows K. Krishnamoothy Edv. Dhv. '55).

(3) Dhv. III. 35;
प्रकारोऽन्यो गुणीभूतव्यङ्ग्यः काव्यस्य दृश्यते ।
यत्र व्यङ्ग्यान्वये वाच्यचारुत्वं स्यात् प्रकर्षवत् ॥

(4) तत्र वस्तुमात्रस्य व्यङ्ग्यस्य तिरस्कृतवाच्येभ्यः प्रतोयमानस्य कदाचिद्वाच्यरूवाक्यार्थापेक्षया गुणीभावे सति गुणीभूतव्यङ्ग्यता । Dhv. III.

(5) Who could be this new ocean of charm
With dark lilies floating beside the moon;
With twin temples of elephants merged
Beside plaintain-stems and lotus-stalks ?

(6) अतिरस्कृतवोच्येभ्योऽपि शब्देभ्यः प्रतीयमोनस्य व्यङ्ग्यस्य कदाचिद्वाच्यप्राधान्येन काव्यचारुत्वापेक्षया गुणीभावे सति गुणोभूतव्यङ्ग्यता । Dhv. III.

(7) Twilight is full of love, etc. (see above).

(8) तस्यैव स्वयमुक्त्या प्रकाशीकृतत्वेन गुणीभावः । Dhv. III.

(9) Knowing the mind of the paramour;
Seeking the time of assignation;
The clever one closed her toy-lotus,
With a smiling glame tell-tale.

(10) For a fuller treatment of rasavadadi alaṃkaras, see my article: 'Rasavadadi Alaṃkaras', Vidya (G. Uni. Journal-Jan. '66)

(11) Dhv. III 37. – वाच्यालंकारवर्गोऽयं व्यङ्ग्यांशानुगमे सति ।
प्रायेणैव परां छायां बिभ्रल्लक्ष्ये निरीक्ष्यते ॥

वाच्यालङ्कारवर्गोऽयं व्यङ्ग्यांशस्यालङ्कारस्य वस्तुमात्रस्य वा यथायोगमनुगमे सति च्छायातिशयं बिभ्रल्लक्षणकारैरेकदेशेन दर्शितः । स तु तथारूपः प्रायेण सर्व एव परीक्ष्यमाणो लक्ष्ये निरीक्ष्यते ।

(12) Dhv. III. 37—तदेपं व्यङ्ग्यांशसंस्पर्शे सति चारुत्वातिशययोगिनो रूपकादयोऽलङ्काराः सव एव गुणोभूतव्यङ्ग्यस्य मागः ।

(13) Dhv. III. 37—तदयं ध्वनिनिष्यन्दरूपो द्वितीयोऽपि महाविषयोऽतिरमणीयो लक्षणोयः सहृदयैः । सर्वथा नास्त्येव सहृदयहृदयहारिणः काव्यस्य स प्रकारो यत्र न प्रतीयामानार्थसंस्पर्शेन सौभाग्यम् । तदिदं कविरहस्यं परमिति सूरिभिर्विभावनीयम् ।

(14 अर्थान्तरगतिः काक्वा या चैक्षा परिदृश्यते ।
सा व्यङ्ग्यस्य गुणीभावे प्रकारमिममाश्रिता ॥ Dhv. III. 38.

(15) Dhv. III 40.

(16) Dhv. III. 4 .—प्रकारोऽयं गुणीभूतव्यङ्ग्योपिं ध्वनिरूपतां ।
धत्ते रसादितात्पर्यपर्यालोचनया पुनः ॥

(17) अत एवेयति वाच्यस्य प्राधान्यं तथाऽपि रसध्वनौ तस्यापि गुणतेति सर्वस्य गुणीभूतव्यङ्ग्यस्य प्रकारे मन्तव्यम् । अत एव ध्वनेरात्मत्वं इत्युक्ततरं बहुशः । लोचन on Dhv. III. 34

(18) अतादृशि गुणोभूतव्यङ्ग्यं व्यङ्ग्ये तु मध्यमम् । K.P I. 3.
अतादृशि वाच्यादनतिशायिनि ।

(19) अत्रादृष्टो यथा न भवसि वियोगभयं च यथानोत्पद्यते तथा कुर्या इति क्लिष्टम् । K.P V.

(20) अत्र परिचुम्बितुमैच्छदिति किं प्रतीयमानं, किं वा विलोकनव्यापारणं वाच्यं प्राधानमिति सन्देहः । K P.V

(21 अत्र जामदग्न्यः सर्वेषां क्षत्रियाणां इव रक्षसां क्षणात्क्षयं करिष्यतीति व्यङ्ग्यस्य वाच्यस्य च समं प्राधान्यम् । K P.V.

(22) अत्र मथ्नाम्येवेत्यादिव्यङ्ग्यं वाच्यनिषेधसहभावेन स्थितम् । K.P.V.

(23) अत्र दत्तसङ्केतः कश्चिल्लतागहनं प्रविष्ट इति व्यङ्ग्यात् सीदन्त्यङ्गानीति वाच्य स चमत्कारम् । K.P.V.

(24) एषां भेदा यथायोगं वेदितव्याश्च पूर्ववत् । K.P.V. 46.a

यथायोगमिति—व्यज्यन्ते वस्तुमात्रेण यदालङ्कृतयस्तदा ।
ध्रुवं ध्वन्यङ्गता तासां काव्यवृत्तेस्तदाश्रयात् ॥

इति ध्वनिकारोक्तदिशा वस्तुमात्रण यत्रालङ्कारो व्यज्यते न तत्र गुणीभूतव्यङ्ग्यत्वम् । K.P.V.

(25) सालङ्कारैः ध्वनेस्तैश्च योगः संसृष्टिसङ्करैः सालङ्कारैः । तैरेवालङ्कारैः अलङ्कारयुक्तैश्च तैः । तदुक्तं ध्वनिकृता —

सगुणीभूतव्यङ्ग्यैः सालङ्कारैः सह प्रभेदैः स्वैः ।
सङ्करसंसृष्टिभ्यां पुनरप्युद्योतते बहुधा इति ॥

अन्योन्ययोगादेवं स्याद्भेदसंख्यातिभूयसी ॥ 89 ॥ K.P.

एवमनेन प्रकारेण अवान्तरभेदगणनेऽतिप्रभूततरा गणना । तथा हि शृङ्गारस्यैव भेदप्रभेदगणनायामानन्त्यं, का गणना तु सर्वेषाम् ।

(26) असतसंदिग्धतुल्यप्राधान्ये मध्यमं त्रेधा । का.शा. II. 57.

(27) क्वचित्पराङ्गत्वेन यथा —

अयं स रशनोत्कर्षी पीनस्तनविमर्दनः ।
नाभ्यूरुजघनस्पर्शी नीविविस्रंसनः करः ॥

the विवेक adds: पराङ्गत्वेनेति। परस्य रसभावतदाभासभावप्रशमभावोदयभावसन्धिभावशवलतारूपस्य वाच्यस्य वाक्यार्थीभूतस्य अङ्गं रसादिवस्त्वलङ्काररूपं वा व्यङ्ग्यं तस्य भावस्तत्त्वम् । तेनेति रसेन ।

(२८) किं च यत्र वस्त्वलङ्काररसादिरूप व्यङ्ग्यानां रसाभ्यन्तरे गुणीभावस्तत्र प्रधानकृत एव काव्यव्यवहारः । तदुक्तं तेनैव-प्रकारोऽयं ... इति । सा.द. IV.

(२९) तदुक्तमस्मत्सगोत्रकविपण्डितमुख्यश्रीचण्डीदासपादैः — काव्यार्थस्याखण्डबुद्धिवेद्यस्य तन्मयीभावेनास्वाददशायां गुणप्रधानभावावभासस्तावन्नानुभूयते, कालान्तरे तु प्रकरणादिपर्यालोचनया भवन्नप्यसौ न काव्यव्यपदेशं व्याहन्तुमीशः, तस्यास्वादमात्रायत्तत्वात् इति । S.D.IV.

(३०) यत्र व्यङ्ग्यमप्रधानमेव सच्चमत्कारकारणं तत् द्वितीयम् । R.G.I.

(३१) काव्यापेक्षया प्रधानीभूतं व्यङ्ग्यान्तरमादाय गुणीभूतं व्यङ्ग्यमादायातिव्याप्तिवारणायावधारणम् । तेन तस्य ध्वनित्वमेव । R.G.

(३२) किं च यत्र वस्त्वलङ्काररसादिरूपव्यङ्ग्यानां रसाभ्यन्तरे गुणीभावस्तत्र प्रधानकृत एव काव्यव्यवहारः । S.D.IV.

इति शिवम् ।

MATERIAL CAPITAL INVESTMENT VERSUS NON-MATERIAL CAPITAL INVESTMENT IN THE THEORY OF GROWTH

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The traditional savings — material — capital investment growth model seems to be dominant to-day. The survey of the articles published in the journals of the two largest professional economic associations, the American Economic Review and the Economic Journal, confirm the dominance of the traditional analysis based on the importance of material capital investment. 40 out of 64 articles, notes and communications dealing with the theory of economic growth in these two journals followed the traditional analysis.[1] Despite the recognition of the important role of non-material capital investment or capital investment in man, the predominance of the traditional model continues in the theory of growth. The purpose of this article is to emphasize the role of non-material capital investment in the process of economic growth. In the first section of the article, the traditional analysis is discussed. The second section examines the importance of non-material capital investment. The third and final section contains the concluding observations on the crucial role of non-material capital investment.

I

The view that the capital investment is the fundamental cause of economic growth is held by many leading economists. Rostow regards the rise of the share of net investment in national income from 5 per cent to over 10 per cent as a pre-requisite for take-off.[2] The United Nation ECAFE experts in their 1960 Report on Programming Techniques for economic development said that the final goal of development planning was to find the best way of breaking the vicious circle between capital shortage and underdevelopment. They regarded material capital accumulation as the core of process of economic growth. Nurkse also emphasized the incremental saving ratio and capital formation.[3] In the survey of the " Economic of Growth" for the American Economic Association Anthology of 1952 almost two-thirds of the total space is given over to capital formation as the fundamental cause of economic growth.[4]

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[1] See Theodore Morgan, 'Investment Versus Economic Growth in Economic Development and Cultural Change', Volume 17, Number 3, April 1969.

[2] W. W. Rostow, 'The Stages of Economic Growth' (Cambridge Press, 1964), p. 37.

The dominance of the traditional role of material capital investment in the theory of economic growth has also influenced the policy planners in many developing countries. Development planners in India had over-emphasized the role of material capital investment in India's Second Five Year Plan. Even now the preoccupation of the Indian planners and government economists with material and physical capital investment as the critical determinant of economic growth continues to influence the Indian economic policy. In many other developing countries, economic growth is regarded as almost synonymous with material capital investment.

But the investment in material capital cannot be a sufficient condition for economic growth. It may at least be a necessary condition for economic growth in certain given circumstances. Non-material capital investment may be far more important in the process of economic growth. Sometimes the high rate of material capital investment may not be associated with the high rates of economic growth. The Secretariat of the Economic Commission for Europe studied the relationship between the conventional capital formation and economic growth for 22 Western Countries in the 1950's. The Secretariat found that there was practically no correlation between the conventional material capital accumulation and economic growth. Theodore Morgan has referred to another similar study for 46 developing countries and has found low correlation between capital investment and economic growth.[5] The low correlation between material capital invest-

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3. Nurkse, Ragner, 'Problems of Capital Formation in Underdeveloped Countries' (New York : Oxford Press, 1953).

4. B. F. Haley, edited, ' A Survey of Contemporary Economics ', Vol. 2, M. Abramovitz "Economics of Growth" (Homewood : Richard Irwin, 1952), p. 132–178.

5. Theodore Morgan in ' Economic Development and Cultural Change ', Vol. 17, Number 3, April 1969, p. 397.

ment and economic growth does not disprove causation but it does show the material capital investment to be relatively unimportant as compared to other factors and influences accounting for the process of economic growth.

There are several situations that permit major increase in economic growth rate without significant increases in material capital investment. The most obvious case is the possibility of the rise in the growth rate from the increased utilisation of capital. The built-in capital and productive capacity may remain idle owing to defective economic organisation. Motivating the organisation might speed up the rate of economic growth without any increase in the rate of material capital investment. It is pertinent to note that there are some capital-output relationships that permit sufficient increases in output without any increase in physical or material capital investment.

II

Recent studies and investigations have indicated the importance of non-material capital in the process of economic growth. According to Schultz, investment in human capital is probably the major explanation for growth in national output[6]. The recent research in the subject has indicated the growth — promoting role of such factors as improvements in organization, in labour quality and technical knowledge. The difference between the growth rates of production and of inputs of capital and labour leave a reisdual. Denison, making estimates of the constituents of the residuals not explained by quantitative inputs shows changes in real U.S. income in 1919-57 originated as follows.[7]

Increase in non-material capital inputs

1. Improvements in labour quality	26 per cent
Technical and organizational advances	32 per cent
Total	58 per cent

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[6] Theodore Schultz, Presidential Address at the American Economic Association Meeting, December 20, 1960 in the American Economic Review (March 1961), pp. 1-15.

[7] E. F. Denison, The Sources of Economic Growth in the United States (New York : CED, Supplementary paper 13, 1962), pp. 266.

Increase in material capital inputs and labour

2.	Increase in labour hours	27 per cent
	Increase in material capital	15 per cent
	Total	42 per cent
	Grand total (1 + 2)	100

Various studies of the inter-relations between material capital, non-material capital and economic growth have shown that a very large proportion of the rise in the per capita output in U.S.A. is due to technical progress rather than to rises in the material capital inputs. Reddaway and Smith, in a study of British Manufacturing Industries, 1948–54, find almost half of growth resulting from the increased labour productivity.[8] Thus technical progress, improvements in quality and skill and productivity of labour and changes in the organization of production account for a large proportion of economic growth. If, therefore, investments are made in education and skill improvement of labour, the rate of economic growth could be accelerated. Surely advancement of technical knowledge and investment in technical education would also speed up the rate of exapansion of the real national product.

The emphasis on the importance of non-material capital investment has certain policy implications for development planning in less developed countries. Often, the improvements in the quality of labour and productivity of labour hinge on the payment of an adequate wage. Consumption standards in developing countries are near the subsistence level and it is essential that the industrial worker ought to consume nutritious food. In order to enable the worker in the less developed countries to pay for the nourishing food, the adequate wage has to be paid. It is found that there is a positive correlation between the intake of nutritive diet and the improvement in labour productivity. Empirical studies have revealed that zero work costs 1500 calories; four hours work costs 2700 calories and eight hours work costs 3900 calories. The low level of the consumption may be more important in explaining the slow rate of growth of output than the low level of the stock of material capital. Thus, investment in consumption may raise the potential output in the developing countries. Therefore, even consumption may be a far more important growthpromoting factor than the material capital. Much of this type of consumption expenditure may turn out to be investment in human capital.

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[8] W. B. Reddayway and A. D. Smith, " Progress in British Manufacturing Industries in the period 1948–54 " Economic Journal (March 1960), Table I, p. 26.

Most people and organizations in the developing countries are working well below their normal production capacities. They have to be persuaded to work more productively. This can be accomplished by introducing suitable schemes of monetary and non-monetary incentives and by bringing about the desirable organizational changes. Thus, the rate of production can be increased without any investment in material capital. After the introduction of incentive schemes based on better motivation, there are wide efficiency gains. Improvement in organization also enchance the productivity of the workers. For example, as a result of 27 productivity missions of International Labour Organization, there was a median rise in work productivity of 41 per cent. Leibenstein also found that the evidence for wide gains from better motivation and improved organization was very impressive.[9]

Direct expenditure on education, health, technical improvement and incentive schemes and changes in organization would be tantamount to investing in non-material capital. These expenditures would raise the present as well as the potential outputs of the economy. Thus, these would be growth promoting expenditures. Investments in improved out of management and technological research might be regarded as more fundamental causes of economic growth. Therefore, in the theory of growth, the role of non-material capital investment should be regarded as the crucial determinant of the process of growth.

III

The foregoing discussion, stressing the crucial role of non-material capital in the process of economic growth, suggests the need for a reformulation of the fundamental growth equation. Conventionally, the fundamental growth equation is expressed in the form of $G = f(K, L, R)$ where G is the rate of growth of real output K, L and R are material capital, labour and natural resources respectively. The fundamental growth equation ought to be restated as : $G = f(N, K, L)$. N stands for investment in non-material capital and alongwith K and L it does embody the use of natural resources. Non-material capital investment would include potential output-increasing outlays such as investments in arts of organization, education, technical knowledge, and in the quality of labour force, health and morale of the work force. Special circumstances of each country would determine the nature and size of the non-material capital investment. Further research might indicate new components of the non-material capital investment. The fundamental problem is to move towards a new theory of economic growth based on the new set of relationships between the investment in non-material capital, material capital and the process of income growth.

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[9] Harvey Leibenstein, " Allocative Efficiency Versus X-efficiency ", American Economic Review (June, 1966), pp. 393–400.

POLITICAL SCIENCE AND POLITICAL PHILOSOPHY : SOME CONSIDERATIONS ON PHILOSOPHICAL AND EPISTEMOLOGICAL FOUNDATIONS OF BEHAVIORAL APPROCH TO POLITICS*

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Though there is a good deal of polemical criticism[1] of the behavioral approach, a dispassionate discussion of its philosophical and epistemological foundations, is hardly to be found.[2]

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[1] (*i*) Leo Strauss : " Epilogue " in H. J. Storing, ed., *Essays in Scientific Study of Politics*. (*ii*) Erich Voegelin : *The New Science of Politics*. (*iii*) Russell Kirk : " Segments of Political Science Not Amenable to Behavioristic Treatment ", in J. C. Charlesworth, ed., *Limits of Behavioralism in Political Science*. (*iv*) Dante Germino : *Beyond Ideology : The Revival of Political Theory* (1967). In this book also the author categorizes behavioralism as a variant of ' neopositivism ' and his criticism too, more or less runs on the same lines as that of Leo Strauss and Erich Voegelin.

[2] There are two good articles discussing limitations of ' behavioralism ' (*i*) Mulford Q. Sibley : " Limitations of Behavioralism ", in C. J. Charlesworth, ed., *Contemporary Political Analysis*. (*ii*) Sheldon S. Wolin "Political Theory : Trends and Goals ", *International Encyclopedia of the Social Sciences*. Both the articles tend to emphasize the necessity of discussing basic philosophical assumptions underlying the behavioral approach. Arnold Brecht : *Political Theory : The Foundations of Twentieth Century Political Thought*, (Princeton, Princeton University Press 1967), is indeed a monumental work discussing philosophical foundations of empirical social research. The book, though written in support of *scientific value relativism*, cannot be categorized as a narrow partisan work. The author, by accepting that "there are certain

Most of those critics take up a philosophical position which is hardly in consonnance with the modern scientific spirit. No durable edifice of any of the social sciences can be built on a priori intuitive premises. Moreover, those critics equate 'behavioralism' with 'behaviorism' and 'logical positivism' and they refuse to look to new dimensions and connotations which the approach has acquired during the last fifteen years. The equation of 'behavioralism' with 'logical positivism' appears really strange if we look to the philosophical underpinnings of the thoughts of prominent behavioral theorists.

Thoughts of Lasswell, Easton and Deutsch show tendencies which appear to be quite contrary not merely to the 'logical positivism' but even to the Weberian position. Lasswell's thoughts, especially his later thoughts, are clearly goal oriented. 'The dignity of man' is the overriding goal and the science of politics is the means of its attainment. Easton in his article on "Harold Lasswell : Policy Scientist for a Democratic Society"[3] clearly shows how Lasswell in his

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universal and invariant elements in the human way of thinking and feeling about values . . . . . " considerably modifies the relativistic position. But in spite of all these, the influence of author's relativistic leanings should not be overlooked. The views which take an integrative view of *science* and *ethics* are either neglected or cursorily discussed. He does not make any reference to the views of J. Bronowaski and Morris Ginsberg. L. T. Hobhouse is casually referred to but his views are not discussed. Karl Mannheim's 'perspectivism' is described as 'extreme relativim', but his philosophical attitudes which circumscribe his 'relativism' are not touched at all. The views of Julian Huxley on 'evolutionary ethics', which appear to have tremendous potentialities for developing scientific insights in normative sides of man's behaviour and for bridging the gulf between 'is' and 'ought' are brushed aside on narrow logical grounds. In fact the whole approachof the author seems to be slightly more 'logic' oriented than 'philosophy of science' oriented. His views on *scientifically transmissible knowledge* need further discussion in the light of different views prevalent on it in the philosophy of science and his views on *ethics* need further discussion in the light of views of Hobhouse, Julian Huxley, Malinowski, and others.

The author, in his later article on "Political Theory : Approaches" in *International Encyclopaedia of the Social Sciences,* David Shills ed., The MacMillan Co., & The Free Press, 1968. (Vol. 12.) states his views more sharply and more precisely but there also, his attitude on substantive issues remains the same.

[3] 12–*The Journal of Politics*, 1950, pp. 451–477.

later works leans towards the position that 'scientific validation of values is possible'. There, Easton does not use the term 'value' in the sense of 'people's desire'; in fact, there, he uses the terms 'value' and 'ought' interchangeably. Nor does he confine its meaning to 'means value'. The conclusion of that article makes it clear. In the conclusion, he says that Lasswell's new orientation raises an extreme claim that social science can make. That claim is nothing less than the claim that "the goals upon which social policy must be based can be established with fully developed science of man".[4] Here, Easton himself not merely welcomes Lasswell's new orientation but he also shows how this search for 'natural law' is vital for providing proper referential framework for social research.

In *The Political System*, Easton expounds more or less similar views. Here, he does not specifically contend that scientific validation of values is possible, nor that it is the ultimate legitimate function of social science. But here, also, he unequivocally agrees that factual and value components are inextricably intertwined and so are causal and moral theories. He writes :

> Rational research requires a complete definition of the way in which we conceive our goals. These goals cannot be fully clarified unless we explore our basic moral views. The latter, in turn, lack full meaning and expression until their knowable consequences are fully worked out. The consequences however, are social in character and, therefore a rational understanding, of the moral frame of reference for an activity such as research compels us to enter into a full inquiry with respect to the application of our goals. We are compelled to project our moral views into an image of the kind of society and political system we would accept as desirable and in this way to formulate a view of what we conceive to be the good political life. Only through an enterprise such as this could we then say that we had clarified our values or made them explicit. Moral clarification requires more than the formal postulation of a few interrelated values. It requires the positive task of constructing an image of the political system flowing from these moral premises. This task we can call the constructive approach towards moral clarification as contrasted with the largely formal approach implicit in the exhortation to avow, affirm, state, or make explicit our values. A construc-

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[4] 12–*The Journal of Politics*, 1950, p. 476.

tive approach requires the synthesis of values with facts to bring out the full meaning of the values.[5]

There can hardly be a more convincing plea than this for an integrative view of ' political science ' and ' political philosophy.' A number of other passages can be cited from *The Political Systəm* to show Easton's deep insight in the intricate interrelations of causal and moral theories. While discussing " The Decline of Modern Political Theory ", he regrets that modern historians of political theory " have assimilated political thoery into empirical and causal social science and have thereby abandoned its genuinely moral aspect ".[6] The history of political theory, he urges, should be treated as a " means for informing the inquirer of alternative moral outlooks with the hope that this would aid him in the construction of his own political synthesis or image of good political life ".[7] He also shows how historical approach of that type strengthens the hold of tradition. In this context he criticizes the attitude of students of political theory to accept " as given, the moral premises of Western Civilization ".[8] This attitude, he writes, " inhibits students of moral theory from making radical exploration into their values "[9] and encourages moral conformity. It seems that here, Easton is fully conscious of the fact that autonomy of empirical theory, i.e., empirical theory divorced from the pursuit of moral clarification, cannot but encourage conservatism. He writes, " The exhortation, therefore, that a research worker need only avow his preferences, in effect makes the assumption that he need not go beyond the accepted values of the day ".[10]

The major concern of Easton, in *The Political System* is to show the necessity of having a conceptual framework of empirical political theory. So naturally, in the concluding chapter of that work, he concentrates on the problems of developing such a framework. In that context, he criticizes the tendency of historians of political theory to overemphasize the history of moral ideas and to neglect the empirical dimensions of classical political theories. But here also, his plea is not for the autonomy of empirical theory. Throughout that work, his contention

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5. David Easton : *The Pclitica Slystem*, (New York, A. A. Knopf, 1966), pp. 230-231.
6. *Ibid.*, pp. 236-237.
7. *Ibid.*, p. 237.
8. *Ibid.*, p. 255.
9. *Ibid.*
10. *Ibid.*, p. 256.

appears to be that, as there cannot be causal theory apart from moral theory, similarly, there cannot be moral theory apart from causal theory. So far as *The Political System* is concerned, Easton's position clearly appears to be that empirical and moral theories are inextricably intertwined and overemphasis on one at the cost of the other is bound to prove harmful to both.[11]

Karl Deutsch's philosophical leanings also appear to run in the same direction. In his article on " Scientific and Humanistic Knowledge in the Growth of Civilization ", he writes, " that the knowledge of that *which ought to be* cannot be divorced from the knowledge of that *which is*, and that the effort to know *what is good* cannot be separated from knowing *what is real* ".[12] He is also fully conscious of the ethical dimensions of scientific endeavours. He writes :

> The relationship of science and values thus implies a double question : the mutual interrelation of science and the general values of a civilization; and the relationship of a specific state of scientific knowledge to the pursuit of specific purposes or policies. The first of these problems, the general relationship of science and value, and thus to some extent of truth and goodness, leads us close to the heart of every civilization within which it is examined. If conceived as mutually incompatible, science and values may frustrate or destroy each other, dragging their civilization towards stagnation or decline. As a mutually productive and creative partnership, science and values may succeed in strengthening each other's powers in a self-enhancing pattern of growth, rendering their civilization increasingly open and able to learn from the hopes and dreams of the individuals within it, as well as from the universe around it.[13]

In *The Nerves of Government* also, he maintains the same view. In the preface of that book, while discussing major objectives of the newly developing political theory, he writes :

> Finally, however, such a theory should link the " is " and the " ought ". It should show the effect of specific facts and policies in the main values that men have held in Western culture; and it should show the significance of

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[11] Easton's philosophical attitude as manifested in his later works is discussed elsewhere in this article.

[12] Published in Harcourt Brown, ed., *Science and the Creative Spirit* p. 47 (University of Toronto 1958).

[13] *Ibid.*, p. 20.

some of our major values for specific policy choices. Beyond this, it should show which policies are likely to prove compatible with the pursuit of a wider range of values, and what values are likely to prove in political practice more compatible with others. Ultimately, a mature theory of this kind should help us to identify viable, growing, and creative patterns of political values and political action.[14]

It is really unfortunate that no attempts are made to perceive the philosophical dimensions of Karl Deutsch's *communication theory*. The theory appears to build a new bridge between empirical pursuits in social sciences on one side and biology, history and philosophy on the other side. His concepts of 'goal or purpose', 'value', 'consciousness' and 'feedback', especially 'self-modifying or goal changing feedback' as enunciated in *The Nerves of Government*[15] seem to have great potentialities for forging new links in that direction. It need hardly be pointed out here that Deutsch's concept of 'life affirming values'[16] and his concept of *the four orders of purposes* of 'a self-modifying feedback net' can be better understood in context of ideas of *evolutionary or scientific ethics* as developed by Julian Huxley. It seems that the study of basic concepts of *the theory of evolutionary ethics* and the *communication theory* can prove mutually beneficial. The study of one in the light of the other is likely to deepen the understanding of both. *The theory of evolutionary ethics* can provide a general referential framework for increasing the inner coherence of many of the basic concepts of *the communication theory*. Whereas *the communication theory* can provide a theoretical framework for increasing the empirical verifiability of basic concepts of evolutionary ethics. Deutsch's *communication theory* seems to add a new dimension to the study of social sciences and if its philosophical aspects are properly brought out, it may add a new dimension to the philosophy of science.

It need hardly be repeated here that with Deutsch, there is no question of 'value-fact' or 'science-philosophy' dichotomy. His philosophical attitude clearly leans towards a unitary view.

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The philosophical underpinnings of the thoughts of other behavioral theorists appear to be somewhat different. *They more emphasize the distinction*

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[14] *The Nerves of Government*, Preface, New York (Macmillan, 1966), pp. xxv–xxvi.

[15] *Ibid.*, pp. 91–93, 178–181, and 200–209.

[16] *Ibid.*, Introduction, p. xiv and pp. 92–93.

between evaluative and explanatory functions and less the interrelations of the two. Though their attitudes have innumerable different shades, it can be said that on the whole, they more lean towards the Weberian position. Their attitude can best be summed up in the following words of David Truman :

> Inquiry into how men *ought* to act is not a concern of research in political behavior. However, the political behavior approach implies no denial of the role of values in the political process. Values, like laws and matters of formal structure, are obviously important determinants of men's behavior and as such they are a part of the data with which political behavior research is concerned.[17]

The views expressed by Truman in his paper on "The Implications of Behavioral Research" deserve a closer study as they properly reflect the philosophical attitude of a number of other behavioral thinkers also. Truman, here, emphatically asserts that political science' as 'a science' is concerned with the explanatory function and the evaluative function does not fall within its sphere. At the same time he asserts the fundamental point of divergence from the 'logical positivist' position by stating that values being facts of life, students of behavioral approach cannot afford to neglect the study of values as 'important determinants of men's behavior'. But he does not stop there and he goes a step further and attempts to show a few other facets of 'value-fact' relationship. He writes that "the values of the investigator are important in the selection of objects and the lines of enquiry . . . . . . "[18] and that the major purpose of the political behavior research is "to indicate the consequences of behavior patterns and of public policy . . . . . . for the maintenance or development of a preferred system of political values"[19]. Moreover, he also concedes the necessity of historical knowledge "as a supplement to contemporary observation of political behavior"[20]. In that context, he also criticizes the attitude to neglect the study of traditional branches of politics. He writes, "any new departure in an established discipline must build upon the accomplishments of the past. Although much of the existing literature of politics may be impressionistic, it is extensive and rich in insights. Without a command of the significant portions of that literature, behavioral research, no matter how systematic, is likely to be naive and unproductive."[21]

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[17] "The Implications of Political Behavior Research", in *Social Science Research Council ITEMS*, Vol. 5, No. 4 (Dec. 1951), p. 39.

[18] *Ibid.*

[19] *Ibid.*

[20] *Ibid.*

Robert Dahl, while discussing the history and growth of the behavioral approach in his article on " The Behavioral Approach in Political Science : Epitaph for a Monument to a Successful Protest "[22] quotes these views of Truman and expresses complete agreement with them. He too criticizes the attitude of taking a rigidly empiricist view of things and pleads to find a place for speculative theories. He expresses a hope that this new influx of empirical inquiry will ultimately forge a new unity among "empirical political science, standards of evaluation, general theory and speculation."[23]

Heinz Eulau in *The Behavioral Persuasion in Politics* upholds the relativistic position by emphasizing the separate functions of science and philosophy. He writes, "the very existence of any scientific enterprise is predicated on inter-subjectively consensual rather than subjectively philosophical notions about man, reality, or universe ".[24] But he too accepts the humanist goals of science and expresses a hope that some day science too may be able to say something on values. He continues, " this something, I daresay, is nothing less than inquiry into the problem of the universality of values . . . . . . "[25] His views appear to fall in line with the position taken up by Arnold Brecht.

Thus, it can be seen that even those behavioral thinkers who are relativistically inclined, never take up a rigid philosophical posture and they maintain a flexible and somewhat open position on the basic philosophical issues.

If we compare the philosophical underpinnings of different behavioral thinkers, two different patterns appear to emerge : (1) the philosophical attitude of Deutsch and Easton (as spelled out in his earlier works) and (2) that of Truman, Dahl and others. Both these views accept the basic objective of moving towards " a science of politics modelled after the methodological assumptions of natural sciences ". But their views as regards " basic assumptions of natural sciences " appear to contain different philosophical nuances : One appears to lean towards emphasizing the unity of knowledge and the interrelations of explanatory and evaluative functions; the other appears to lean towards emphasizing distinctive characters of those functions. One emphasizes the attitude that ethical norms as other facts of life should be considered to be amenable to the processes of science; the other emphasizes that even if ethical norms are ultimately amenable to those processes, at least under the present stage of scientific development, we are not in a position to probe empirically into them, and so better we keep the empirically verifiable and empirically non-verifiable components separate. It need hardly be pointed out here that these different philosophical nuances have vital methodological implications.

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[21] Ibid.

[22] *The American Political Science Review* — December 1961.

[23] *Ibid.*, p. 770.

[24] Heinz Eulau : *The Behavioral Persuasion in Politics* (Random House), p. 134

[25] *Ibid.*, p. 135.

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Looking to the later works of Easton, it is very difficult to say whether he still continues to hold the same views as he has expounded in *The Political System* or his views have undergone any change. In *A Framework for Political Analysis* and in *A Systems Analysis of Political Life*, he concentrates on the development of a conceptual framework for empirical political theory and so naturally, there, he does not discuss (except in an elementary way in the introductory chapters) the philosophical foundations of political sicence research. But in the introductory chapters, he clearly shows that he takes *The Political System*, *A Framework of Political Analysis*[26] and *A Systems Analysis of Political Life*[27] as parts of a continuous endeavour and so it should be presumed that he continues to hold the same views as in *The Political System.*

However, a close study of the introductory chapters of *A Framework of Political System* and *A Systems Analysis of Political Life*, somehow, leaves an impression on the reader's mind that there is some change in his philosophical attitude, if not of substance, of emphasis. In *The Political System* the emphasis appears to be on the development of an empirical theory in context of " a continuous process of moral clarification ". In his later works the emphasis appears to be on the development of a pure empirical theory, as far as possible, ' detached from its ethical and historical entanglements '. This shift is clearly discernible in one of his later articles on " Political Science " in *International Encyclopaedia of The Social Sciences*. Therein, while discussing the impact of technical revolution on the behavioral approach, he writes, the technical revolution "has brought about a profound transformation in conceptions about the role that theory plays as a tool for political research. Thereby it has tended to drive political science away from a prescriptive, problem-directed discipline to one in which research depends increasingly upon empirically oriented theoretical criteria ".[28]

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[26] (Englewood Cliffs, Prentice-Hall, N. J. 1965).

[27] (N. Y., John Wiley and Sons, 1965).

He categorizes the behavioral approach prior to 1960 as ' problem oriented ' and post 1960 approach as dominated " by growing commitment to the goals and methods of a rigorous science ". In the post-1960 period " understanding began to take logical and chronological priority over premature efforts to prescribe policies ".[29]

In that context, he writes that when the approach was problem oriented and the issues were discussed in context of ethical purposes, " the ethical purposes defined at least some outer limits on the range of research ". " But when, by the 1960's, these ethical criteria began to disappear, the gates were opened wide to an unrestrained flood of empirical research ".[30] Here also, he agrees that there can hardly be any meaningful research without conjoining it with some criteria of relevance, and in this context, he writes that in post 1960's, theoretical criteria became a limiting and ordering factor, in place of ethical criteria of the past.

Unfortunately, he does not clarify anywhere whether the theoretical criteria to which he refers in that article bears any type of relation to moral criteria or not. If he means by theoretical criteria same as ' pure science criteria ' without having any relation to moral criteria, then, it becomes very difficult to reconcile his earlier and his later views. The distinction he makes between pre-1960 ' problem oriented approach ' and post 1960 ' pure science approach ' appears to indicate that he has outgrown his earlier views and he has moved towards the relativistic position. If there is really such a shift in his views, all the questions which Easton has so ably posed in his earlier works against relativistic position, come up against him also. Can there be any meaningful social research without any direction indicated by 'a moral framework'? Is 'simple play of imagination' enough to develop insight in social relations or can it come only through 'the immersion in different value assumptions'?[31] Are values not likely to creep in 'through the back door if we keep pure science as our objective'?[32]

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[28] David Easton : " Political Science " in *International Encyclopaedia of the Social Sciences,* David L. Sills, ed. (The MacMillan Co., & The Free Press, 1968), Vol. 12, p. 296.

[29] *Ibid.*

[30] *Ibid.*, p. 297.

When Easton refers to theoretical criteria, perhaps he may have in mind the type of theoretical macro-models which Deutsch discusses in *The Nerves of Government*. But it can hardly be forgotten that those theoretical models of Deutsch are based on an integrative view of science and philosophy.

It seems that Easton is conscious of the difficulties involved in accepting such a relativistically inclined position. He writes, "however, the clarification of the role of values and prescription in the methods of political analysis has posed a new and serious problem".[33] But he expresses a hope that, "it is through efforts to meet and conquer this problem that we can anticipate an acceleration in the conversion of political science from a synthetic science to a pure science".[34] He does not show anywhere what the nature of that 'new and serious problem' is and how the newly growing theoretical matrix — theoretical matrix largely based on the idea of value-fact separation — is likely to solve it.

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While the views of David Easton appear to have moved in the direction of 'pure science' theory, the views of David Truman and Robert Dahl appear to have moved in a somewhat different direction. David Truman, in his presidential address[35] to the 1965 annual meeting of the American Political Science Association, sets in motion a new philosophical trend in behavioral thought. In that address, he reiterates his plea for a new harmony between the traditional political studies and the behavioral approach and for creating 'a fresh consensus in the discipline'. But here, he does not stop there. He goes a step further and shows how rigidly empiricist view is inadequate and some infusion of speculative element is inevitably necessary for proper understanding of political life. He further says, "we cannot escape the obligation to predict, and a function of prediction is to sharpen and to broaden moral choice "[36]. Moreover, here he expresses a view that for a long time to come, if not permanently," the discipline will have to place some reliance upon knowledge that is less scientific or even non-scientific in character "[37]. But more important than all that, is the fact that, in that address, he tries to seek support for his views by moving towards a broader view of science as advocated by Thomas Kuhn[38] and Ernest Nagel.[39] It need hardly be pointed out here that those views differ much from the Weberian or the Brechtian concept of science. Kuhn emphasizes the discontinuous aspects of scientific development and Nagel leans towards hedonistic view of ethics. Each of the positions is quite opposed to the position taken up by Arnold Brecht.

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[31] David Easton, "Harold Lasswell: Policy Scientist for a Democratic Society", 12–*Journal of Politics* –1950, p. 469.

[32] *Ibid.*, p. 476.

[33] "Political Science", *International Encyclopaedia of the Social Sciences,* Vol. 12, p. 296.

[34] Ibid., p. 297.

[35] "Disillusion and Regeneration : The Quest for a Discipline", *The American Political Science Review,* December 1965.

A similar trend is discernible in the philosophical underpinnings of Robert Dahl. In his paper on " The Evaluation of Political Systems " in Ithiel de Sola Pool ed. *Contemporary Political Science : Toward Empirical Theory*,[40] Dahl regrets the attitude of behavioral scientists for not paying proper attention to the function of evaluation and shows how certain empirical methods can be profitably utilized for scientific assessment of values. In this context, he raises a note of caution that whatever the potentiality of empirical method, " the element of judgment in making appraisals would not be eliminated or for that matter even reduced ".[41] He enumerates the stages at which judgment enters in empirical studies and says, " in short, to handle data requires judgments, and to handle data sensibly requires good judgment "[42]. He continues :

> Even when all these data problems have been met, there still remain fundamental questions of judgment that transcend ordinary considerations

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[36] *Ibid.*, p. 873.

[37] *Ibid.*, p. 872.

[38] Thomas S. Kuhn : *The Structure of Scientific Revolutions* Chicago, (The University of Chicago Press, 1962).

[39] Ernest Nagel : *The Structure of Science : Problems in the Logic of Scientific Explanation* (New York, Harcourt, Brace and World, 1961).

[40] New York, McGraw Hill Book Company, 1967.

[41] *Ibid.*, p. 176.

[42] *Ibid.*, p. 177.

of methodology — questions, in fact, that are not much treated in books on method and statistics, for they seem to defy elaboration, or at any rate it seems difficult to do more than elaborate the obvious. Does the analysis seem to us truly valid, relevant, important ? At this stage we introduce not only explicit knowledge but what Michael Polanyi has called "tacit knowledge[43] ".

It need hardly be mentioned here that Polanyi's views of 'scientific knowledge' run in a quite contrary direction to those of Arnold Brecht.

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The attitude of Truman and Dahl clearly shows one thing that both of them find the relativistically oriented empiricist jacket too tight and they are in search of a broader view of science. It also appears to indicate that mere commitment to empirical method is not enough and some thing more is needed. It also points to the fact that problems of scientific methodology can, under no circumstance, be divorced from the basic problems of the philosophy of science and ultimately those of the philosophy in general.

This attitude of Dahl and Truman appears to reflect a new mood that is gradually dawning in our discipline. Sheldon S. Wolin in the conclusion of his article on "Political Theory : Trends and Goals" clearly reveals this new mood, when he says :

> Perhaps the most important problem besetting contemporary political theory is not the question of whether theory ought to be firmly wedded to the methods and outlook of the natural sciences, but rather what version of science it will choose : the rigorous, fact—minded, anticonceptual view which believes that cumulative knowledge is the result of patient and dogged application of scientific methods or the view of science as an imaginative undertaking, with its full share of speculation, playfulness, proclivity to error, and its ability to imagine worlds as yet undreamed of — an ability which would maintain the critical, projective quality that has enabled past theories to speak meaningfully to the quandaries of political existence.[44]

This new mood is no doubt a sign of new health. None can deny the validity of the plea that without some broadening of our view of science. we can never hope to forge a synthesis between 'empirical knowledge' and 'speculative elements of knowledge' — a synthesis without which we can never hope to equip ourselves with a ' sense of perspective ' or a ' sense of direction '. At the same time, we cannot forget the fact that if narrow empiricist view divorces us from deeper currents of life, too imaginative a view may separate us from ' matters of fact ' currents of life and may *ultimately* lead us to the Platonic position. None of the extreme positions can help us much. Only a judicious synthesis of ' empiricism and romanticism ' can help us.

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[43] *Ibid.*

[44] In David L. Sills, ed., *International Encyclopedia of the Social Sciences*, (1968), Volume 12, p. 329.

When we think of moving from Max Weber and Arnold Brecht to Kuhn and Polanyi,[45] let us not forget that we are thinking of a major departure, a fundamental change. We should be prepared to do it, but not without proper consideration of the issues involved in that change and also of the likely consequences of that change on our fundamental commitment to empiricism. A few questions appear to be pertinent at this juncture. How far are views of ' science ' as expressed by Kuhn and Polanyi, consistent with our view of scientific knowledge as inter-subjectively transmissible knowledge ? Can we accept Polanyi's concepts[46] of ' *tacit knowledge* ' and ' *explicit knowledge* ' and his view of superiority of the former over the latter and still remain faithful to the empiricist view of science ? Is ' judgment ' only a matter of ' *intuition* ' ? Can experience, historical insight, proper training, and ' systematic and dispassionate empirical investigations ' gradually improve the quality of ' judgment ' itself or not ? Is '*historical knowledge*', in spite of all its unscientific characters, not a somewhat more dependable guide than ' *personal knowledge* ' ? Has not our aversion to dogmatist Marxist historicism created in our minds a deep seated bias against historical knowledge in general ? Is that bias not likely to prevent us from understanding the proper worth of history ' as an indicator of major currents of our social existence ' ? Can we ever hope to formulate a somewhat clear ' theory of development ' without having some idea of ' progress ' — the idea of ' direction towards which things move and towards which they *ought* to move ' ? Are the views of ' evolutionary ethics ' (as developed by L. T. Hobhouse, Morris Ginsberg and Julian Huxley) which attempt to trace normative aspects of behavior to their biological, psychological and historical roots, not somewhat nearer the scientific approach than relativistic or mystic views on ethics ? Is it not the time to look back and review the philosophical attitudes of eminent founder thinkers like Auguste Compte, Emile Durkheim, Karl Marx, John Stuart Mill, L. T. Hobhouse, Karl Mannheim and Sigmund Ereud over and above that of Max Weber and try to find out whether they can provide any further insight for empirical study of deeper currents of human behavior or not ?

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[45] See the above referred paper of Dahl in Ithiel de Sola Pool, ed., *Contemporary Political Science : Toward Empirical Theory* and Mulford Q. Sibley's " The Limitations of Behavioralism ," in J. C. Charlesworth, ed., *Contemporary Political Analysis.*

[46] Michael Polanyi : *Personal Knowledge*, New York Harper and Row, (19 8)

No doubt any discussion of epistemological and philosophical foundations of social science methodology is bound to raise many intricate and abtruse points and we may not be able to shed any more light on many of them for some time to come. But for that matter, we cannot relax our efforts to grapple with these problems, as such efforts constitute our only hope to see light and to understand things better. In this context, one more question also appears to be pertinent. Is interdisciplinary dialogue between political science and philosophical aspects which are nearer to it, such as comparative ethics, philosophy of science and philosophy of history, not as much relevant as interdisciplinary dialogue between political science and psychology or between political science and statistics ?

Until now behavioral theorists appear to have shown preference for avoiding discussion of the basic philosophical issues on the ground that such discussions usually assume polemical shape and it is better that political scientists devote themselves to the development of an empirical theory rather than fritter away their energies in such philosophical discussions. The attitude, no doubt, had some justification when the approach was in its initial stage and when it had to fight an uphill battle against the old guards to secure a place in the establishment. But, is it justifiable today when the "Young Turks" have become "Old Turks" and when the new "Young Turks" are coming up to challenge the new "Old Turks" ? Under the present circumstances, does the reluctance to discuss basic issues not prove harmful to the approach than helpful to it ? Is it not the time to think again of the basic issues and to review which of the different philosophical attitudes held by different behavioral thinkers as regards interrelations of 'the pursuit of truth' and 'the pursuit of good' appears to be more valid and more helpful to the further development of the approach ?

Behavioral approach to politics appears to be on the point of completing a circle. Not long ago, many of us believed that there can be 'political science without political theory'. Gradually we realized our error. Today hardly anybody believes in it. Looking to the present mood of our discipline a question naturally arise in our minds whether we are not committing the same type of error when we say that 'there can be political science without political philosophy'.

ગુજરાતનાં પૂર્વ-ચૌલુકયકાલીન મંદિરોનું રચનાવિધાન

ડૉ. કાંતિલાલ ફૂ. સોમપુરા

એચ. કે. આર્ટ્સ કૉલેજ, અમદાવાદ--૯

રચના પરત્વે ગુજરાતમાં મંદિર-સ્થાપત્યની બે પરંપરા જોવામાં આવે છે. પ્રથમ પરંપરા ઈસુની ૫મી સદીથી ૧૦મી સદીના પૂર્વાર્ધ સુધી વ્યાપક બની હતી. આ શૈલીનું પ્રાચીનમાં પ્રાચીન મંદિર સૌરાષ્ટ્રના બરડાના ડુંગરમાં આવેલું ગોપનું મંદિર છે. આ પરંપરાનું ખૂબ જ વિકસિત સ્વરૂપ સાબરકાંઠા જિલ્લાના રોડાના મંદિરસમૂહમાં જોવા મળે છે. રોડા-મંદિરસમૂહનો સમય ઈસુની સાતમી સદીનો ઉત્તરાર્ધ આને આઠમી સદીનો પૂર્વાર્ધ મનાય છે. પ્રથમ પરંપરાનાં આ મંદિરો પૂર્વચૌલુકય શૈલી(Pre-Caulukyan)નાં મંદિરો તરીકે ઓળખાય છે.

આ શૈલીનું પ્રાચીનતમ મંદિર ગોપ[૧] (જિ. જામનગર)માં હોવાને કારણે કેટલાક આ સમૂહનાં મંદિરોને ગોપશૈલીનાં મંદિરો તરીકે પણ ઓળખે છે. સૌરાષ્ટ્રમાં આ શૈલીનાં બીજાં ઉત્કૃષ્ટ મંદિરોમાં જૂનાગઢ જિલ્લાના કદવાર[૨] (વરાહમંદિર ૫મી સદી) સૂત્રાપાડા[૩] તથા વીસાવાડા[૪]નાં મૈત્રકકાલીન (ઈ.સ. ૪૭૦-૭૮૮) સૂર્યમંદિરો; તથા બીલેશ્વર[૫]નાં શિવમંદિર તેમ જ કિંદરખેડા[૬]નાં ચામુંડા અને સૂર્યમંદિર, પાસ્થર[૭]ના સૂર્યમંદિરની તથા ભાવનગર

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૧. બર્જેશ, જે. "રિપોર્ટ ઑન ધી એન્ટિકિવટીઝ ઑફ કાઠિયાવાડ ઍન્ડ કચ્છ" (૧૮૭૬), પૃ. ૧૮૭, પ્લેટ્સ ૫૧-૫૩; સાંકળિયા એચ. ડી., "આર્કિયોલોજી ઑફ ગુજરાત" (૧૯૪૧), પૃ. ૫૬-૫૯; સોમપુરા કે. એફ., "ધી સ્ટ્રકચરલ ટેમ્પલ્સ ઑફ ગુજરાત" (૧૯૬૮), પૃ. ૭૬, ચિત્ર નં. ૧ તથા ૨૧૫.

૨. કઝન્સ, એચ.: "સોમનાથ ઍન્ડ અધર મિડાઈવલ ટેમ્પલ્સ ઑફ કાઠિયાવાડ" (૧૯૩૧), પૃ. ૩૮-૩૯, પ્લેટ્સ ૩૯-૩૫; સાંકળિયા, ઉપરોકત, પૃ. ૬૩; સોમપુરા, ઉપરોકત, પૃ. ૭૬-૭૭, ચિત્ર નં. ૨, ૨૧૯.

૩. કઝન્સ, ઉપરોકત, પૃ. ૪૧, પ્લેટ્સ ૪૦-૪૧; સોમપુરા, ઉપરોકત, પૃ. ૮૦-૮૧, ચિત્ર નં. ૩, ૨૧૮.

૪. કઝન્સ, ઉપરોકત, પૃ. ૪૪-૪૫, પ્લેટ ૪૫; સોમપુરા, ઉપરોકત, પૃ. ૮૧-૮૨, ચિત્ર નં. ૫.

૫. કઝન્સ, ઉપરોકત, પૃ. ૪૦, પ્લેટ્સ ૩૬-૩૯; સોમપુરા, ઉપરોકત, પૃ. ૯૨-૯૩, ચિત્ર નં. ૩૭-૩૮.

૬. કઝન્સ, ઉપરોક , પૃ. ૪૧-૪૨, ચિત્ર નં. ૩, પૃ. ૪૨; સોમપુરા, ઉપરોકત, પૃ. ૯૨, ચિત્ર નં. ૩૯.

૭ બર્જેશ, ઉપરોકત, પૃ. ૧૮૬; સોમપુરા, ઉપરોકત, પૃ. ૯૩.

જિલ્લાના કલસાર[૮] વગેરે સ્થળોએ આવેલાં અનુમૈત્રકકાલીન (ઈ.સ. ૭૮૮-૯૪૨) પ્રાચીન મંદિરોની ગણના થાય છે. તદુપરાંત જૂનાગઢ જિલ્લાના ભાણસરનો મંદિરસમૂહ; બોરીચા[૯]નાં શિવ, સૂર્ય તથા સપ્તમાતૃકાનાં મંદિરો; ખીમેશ્વર તથા નંદીશ્વરનો મંદિરસમૂહ; ઓડદરનાં પ્રાચીન મંદિરો, અખોદરનું સૂર્યમંદિર, પસનાવડા[૧૦]નાં નાગ, સૂર્ય અને ગાયત્રીમંદિર; પોરબંદરનું પોરાદેવીમંદિર, રાણાવાવનું જાડેશ્વરમંદિર, શ્રીનગરનાં સૂર્ય, શિવ અને વિંધ્યવાસીનીનાં મંદિરો, મીંયાણીનાં પ્રાચીન મંદિરો, બલેજના સૂર્ય, કોઠ અને પીથડમાતાનાં મંદિરો; બોખીરાનું ચામુંડામંદિર, છાયાનાં ધીંગેશ્વર અને અંજલિમાતામંદિર; કુછડીનું દુર્ગામંદિર, સવની[૧૧]નું પ્રાચીન મંદિર, ઝામરા[૧૨]નું સૂર્યમંદિર, નાવદ્રા[૧૩]નું કાલિકામંદિર તથા જામનગર જિલ્લાના ધ્રાસણવેલનાં કાલિકા અને મગદેરું; નવી ધ્રવેડનું કાલિકામંદિર, પીંડારા[૧૪]નું પ્રાચીન મંદિર. ખીમરાણ[૧૫]નું શિવમંદિર, કાલાવડનું કોટેશ્વર મંદિર, સુવાન[૧૬] (સુવર્ણતીર્થ કે બરવાળા), દેગામ,[૧૭] સરમા[૧૮] વગેરે સ્થળોનાં મંદિરો પૂર્વચૌલુકયકાલીન મંદિરો છે.[૧૯]

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૮. ઈ.સ. ૧૯૧૨માં કલસારના મંદિર પર પ્રથમ નોંધ ગિરિજાશંકર વી. આચાર્યે પ્રકટ કરી (એન્યુઅલ રિપોર્ટ, વૉટ્સન મ્યુઝિયમ, ૧૯૧૨-૧૩) ત્યાર પછી શ્રી. રવિશંકર રાવળે તેનો ફોટો, સ્કેચ તથા તલમાન (ground-plan) અંગેની નોંધ પ્રકટ કરી (જર્નલ ઑફ ગુજરાત રિસર્ચ સોસાયટી, વૉ. ૧૧, અં. ૨, પૃ. ૮૧-૮૮).

૯. પોરબંદર પાસે આવેલા આ સ્થળનાં મંદિરોની શોધ ડૉ. એચ. યુ. ત્રિવેદીએ ઈ.સ. ૧૯૫૩માં કરી હતી.

૧૦. પ્રો. એમ. જે. પાઠક તથા શ્રી. પ્રભાશંકર હરિશંકર શાસ્ત્રીએ પસનાવડાના ગાયત્રીમંદિર પરની નોંધ પ્રથમ પ્રકટ કરી (જર્નલ ઑફ આર્કિયોલોજિકલ સોસાયટી, જૂનાગઢ, વૉ. ૨, ભા. ૧, માર્ચ, ૧૯૪૦).

૧૧. તથા ૧૩. આ બન્ને મંદિરોની શોધ શ્રી. હરિશંકર પ્ર. શાસ્ત્રી તથા મધુસૂદન ઢાકીએ ઈ.સ. ૧૯૫૬માં કરી તથા સર્વશ્રી ઢાકી, શાસ્ત્રી તથા ડૉ. પનુભાઈ ભટ્ટે પસનાવડાના સૂર્યમંદિર પર નોંધ પ્રકટ કરી (ઇંડિયન આર્કિયોલોજી, ૧૯૬૦-૬૧, પૃ. ૫૮). અહીંના નાગમંદિરની શોધ સર્વશ્રી ઢાકી, શાસ્ત્રી તથા જે. એમ. નાણાવટીએ સને ૧૯૬૧માં કરી હતી.

૧૨. અહીંનું સૂર્યમંદિર ડૉ. પનુભાઈ ભટ્ટે ઈ.સ. ૧૯૬૦માં શોધ્યું (ઇંડિયન આર્કિયોલોજી, ૧૯૬૦-૬૧, પૃ. ૫૮).

૧૪.-૧૫. આ બન્ને મંદિરોની શોધ સ્વ. પી. પી. પંડયાએ ઈ.સ. ૧૯૫૩માં કરી હતી.

૧૬. સને ૧૯૫૭-૫૮માં શ્રી. અમૃત વસંત પંડયાએ આ મંદિર વિશે માહિતી આપી હતી.

૧૭-૧૮. આ બન્ને મંદિરો શ્રી. નાણાવટી તથા શ્રી. ઢાકીએ શોઢી કાઢયાં છે. વળી સૌરાષ્ટ્રના ઉપરોકત સર્વમંદિરોનો વિસ્તૃત અભ્યાસ તે બન્ને વિદ્વાનોએ કર્યો છે, તે પરનો તેમનો અંગ્રેજીમાં રચાયેલો ગ્રંથ ટૂંક સમયમાં પ્રસિદ્ધ થનાર છે.

૧૯. પોરબંદરની આર્કિયોલોજિકલ રિસર્ચ સોસાયટીના પ્રમુખ શ્રી. મણિલાલ વોરાએ સૌરાષ્ટ્રનાં ઘણાં પ્રાચીન મંદિરો પર મૂલ્યવાન સંશોધનો કર્યાં છે. શ્રીનગર, બીલેશ્વર, નંદીશ્વર, બલેજ, ભાણસર, ઓડદરના મંદિરસમૂહો તથા પોરબંદર, છાયા, બોખીરા, વીસાવાડા, કુછડી, રાણાવાવ, અખોદર, મેવાસા, કાલાવાડ વગેરે સ્થળોનાં પ્રાચીન મંદિરો તેમણે શોધ્યાં છે. તેમના અનુરોધથી ઉપર જણાવેલાં ઘણાં સ્થળોએ મેં ઈ.સ. ૧૯૬૨માં જાતે ફરીને ઘણી માહિતી એકત્રિત કરેલી. આ માહિતી વ્યવસ્થિત સ્વરૂપે મેં મારા ગ્રંથ "ધી સ્ટ્રકચરલ ટેમ્પલ્સ ઑફ ગુજરાત"ના ઍપેન્ડિક્સ 'એ' (પૃ. ૪૮૯-૫૦૬)માં વિસ્તૃત સ્વરૂપે રજૂ કરી છે.

સમતલદર્શન(ground plan)ની દૃષ્ટિએ આ મંદિરોનું વર્ગીકરણ આ પ્રમાણે યોજાયેલું જણાય છે. આમાંના કેટલાંક મંદિરો માત્ર ગર્ભગૃહનાં બનેલાં છે. મીંયાણી પાસેની હરસિદ્ધમાતાની ટેકરીના ઢોળાવ પર આવેલું પ્રાચીન મંદિર, ભાણસર નં. ૩ અને ૪નાં મંદિરો; નંદીશ્વર નં. ૧ તથા ૩; ઑડદર-મંદિરસમૂહ પૈકીનું પૂર્વ તરફ આવેલું પ્રાચીન મંદિર તથા પાતાનાં બે મંદિરો માત્ર ગર્ભગૃહનાં બનેલાં છે.

કેટલાંક મંદિરોનાં ગર્ભગૃહની સન્મુખે મુખમંડપ કે શૃંગારચોકીની રચના જોવામાં આવે છે. સોનકંસારીમંદિર નં. ૫, ખીમેશ્વર નં. ૫ તથા ૭, કિંદરખેડાનું ચામુંડામંદિર, બોરીચા અને પાતાનાં સપ્તમાતૃકામંદિરો, પોરબંદરનું ધીંગેશ્વરમંદિર, ઓડદરમંદિર નં. ૩ તથા નંદીશ્વરમંદિર નં. ૨, ૪ અને ૫ આ પ્રકારનાં મંદિરો છે.

પૂર્વચૌલુક્ય શૈલીનાં ઘણાં મંદિરોના ગર્ભગૃહની સન્મુખે ગૂઢમંડપની રચના હોય છે. આ ગૂઢમંડપો મોટે ભાગે ભીંતાસ્તંભો (pilasters) પર ટેકવેલા હોય છે અને કવચિત્ મંડપમાં બે કે ચાર છૂટા સ્તંભો (free-standing pillars) પણ જોવામાં આવે છે. વીસાવાડાનું શિવમંદિર, પસનાવડાનાં સૂર્ય, ગાયત્રી અને નાગમંદિર; પાતાનું સૂર્યમંદિર, કુછડી અને દેગામનાં ચામુંડામંદિરો; નાવદ્રાનું કાલિકામંદિર, સૂત્રાપાડાનું નવદુર્ગામંદિર, સોનકંસારીમંદિર નં. ૩, બલેજનું કોઠમંદિર વગેરે ગર્ભગૃહ અને ગૂઢમંડપનાં બનેલાં છે, કવચિત્ આ પ્રકારનાં મંદિરોની સન્મુખે શૃંગારચોકી પણ આવેલી હોય છે. વળી આ સમૂહનાં કેટલાંક મંદિરોનાં ગર્ભગૃહો ચોરસને બદલે લંબચોરસ ઘાટનાં પણ હોય છે. આ શ્રેણીમાં કલસારનું પ્રાચીન મંદિર, ખીમેશ્વરમંદિર નં. ૭, સવનીમંદિર નં. ૫ તથા સોનકંસારીમંદિર નં. ૫ અને શામળાજીના પ્રાચીન સૂર્યમંદિરનો સમાવેશ થાય છે.

આ શૈલીનાં કેટલાંક મંદિરો સાંધાર એટલે કે ગર્ભગૃહની ચોતરફ પ્રદક્ષિણાપથની યોજનાવાળાં છે. ગોપનું પ્રાચીન મંદિર,[૨૦] કદવારનું વરાહમંદિર,[૨૧] સૂત્રાપાડા[૨૨] અને અખોદરનાં સૂર્યમંદિરો, વીસાવાડાનું રાંદલમંદિર,[૨૩] ઝામરાનું સૂર્યમંદિર, ધ્રાસણવેલનું કાલિકામંદિર, બલેજનું પીથડમાતાનું મંદિર અને ભાણસરમંદિર નં. ૩ તથા ખીમેશ્વરમંદિર નં. ૨ આ પ્રકારનાં મંદિરો છે. આ સાંધારમંદિરોમાંના કેટલાંકની સન્મુખે વળી શૃંગારચોકીની પણ રચના જોવામાં આવે છે. મેવાસા પાસેનું ચેલેશ્વરમંદિર આ પ્રકારનું છે. નવી ધ્રવેડના કાલિકામંદિરમાં પણ આવી રચના છે અને તેની શૃંગારચોકીમાં ત્રિચોકીની યોજના છે.

સુવાન (સુવર્ણતીર્થ) કે બરવાળાનું જગન્નાથમંદિર, પોરબંદર પાસેના છાયાનું અંજલિમાતામંદિર, સોનકંસારીમંદિર નં. ૧ તથા ૨, ખીમેશ્વરમંદિર નં. ૧, શ્રીનગરનું વિંધ્યવાસિનીદેવીમંદિર, કિંદરખેડાનું સૂર્યમંદિર, બોખીરાનું ચામુંડામંદિર, પ્રાચીન ભીમદેવલ વગેરે મંદિરોમાં

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[૨૦] બર્જેશ જે., ઉપરોક્ત, પ્લેટ ૫૨; સોમપુરા, ઉપરોક્ત, ચિત્ર નં. ૨૧૫ અને ૨૧૬.

[૨૧] કઝન્સ એચ., ઉપરોક્ત, પ્લેટ ૩૩; સોમપુરા, ઉપરોક્ત, ચિત્ર નં. ૨૧૯.

[૨૨] બર્જેશ, ઉપરોક્ત, પ્લેટ ૪૨; સોમપુરા, ઉપરોક્ત, ચિત્ર નં. ૨૧૮.

[૨૩] બર્જેશ, ઉપરોક્ત, પ્લેટ ૪૫; સોમપુરા, ઉપરોક્ત, ચિત્ર નં. ૨૧૭.

પૂર્વચૌલુક્ય શૈલીનાં મંદિરોમાં દેખા દેતાં સર્વ અંગોનો સમાવેશ થાય છે. આ મંદિરો ગર્ભગૃહ, પ્રદક્ષિણાપથ, ગૂઢમંડપ અને શૃંગારચોકીનાં બનેલાં છે.

પૂર્વચૌલુક્ય શૈલીનાં કેટલાંક મંદિરો વળી રચના પરત્વે ત્ર્યાયતન, પંચાયતન અને સમાયતન હોવાનું પણ જાણવા મળે છે. સરમાનું એક પ્રાચીન મંદિર ત્ર્યાયતન છે. પાસ્થર અને મીંયાણીનાં પ્રાચીન મંદિરો પૈકીના એક એક મંદિર પંચાયતન અને ધ્રાસણવેલનું મગદેરું સમાયતન પ્રકારનાં મંદિરો છે.

ઊર્ધ્વદર્શન (elevation)ની દૃષ્ટિએ પૂર્વચૌલુક્ય શૈલીનાં મંદિરોની બાહ્ય દીવાલો બહુધા સાદી હોય છે, અને તેમાં જમીનતલથી શિખરના પ્રહાર (entablature)ના થર સુધી ઊભી કરવામાં આવેલી દીવાલોમાં ભદ્રાદિ નિર્ગમો (projections) હોતાં નથી. તેમ છતાં કેટલાંક મંદિરોની બાહ્ય દીવાલોના પીઠ ભાગે પદ્મ કે જાડ્યકુંભ (જાડંબો—inverted-cyma-recta), ક્ષેપણ (અંતરપત્રિકા–fillet), કુમુદ (કુંભ--torus), કપોતાલી (કેવાળ--cyma-recta as roll cornice), ક્ષોણી (છાદ્ય--eave), વાજન (પટ્ટિકા--frieze), વલભી (કૂટ-છાદ્ય--eave) વગેરે થરો(mouldings)થી વિભૂષિત કરવામાં આવી છે. નંદીશ્વરમંદિર નં. ૨, ૩, ૪, ૫; ઓડદરમંદિર નં. ૩, સોનકંસારીમંદિર નં. ૨, ૩ તથા વીસાવાડાના રાંદલમંદિર, પ્રાચીના ભીમદેવલ અને પાતાનાં બે ભગ્ન મંદિરોની દીવાલોમાં આ થરો આવેલા છે. સરમાના ત્ર્યાયતન મંદિરની દીવાલો, પાસ્થર અને મીંયાણીનાં પંચાયતન મંદિરોની દીવાલો તથા ધ્રાસણવેલના સમાયતન મગદેરાના મંદિરની દીવાલો પણ આ જ પ્રકારના થરોથી વિભૂષિત છે. આ શૈલીનાં મંદિરોના મંડપોના સ્તંભો સાદા અને ચોરસ ઘાટના છે અને ક્વચિત્ તેમાં કુંભી (base)નો અભાવ વર્તાય છે.

પરંતુ પૂર્વચૌલુક્ય શૈલીનાં આ મંદિરોના ગર્ભગૃહ ઉપર શિખરની રચના વિશિષ્ટ રીતે પાછલા સમયનાં ચૌલુક્યકાલીન મંદિરોથી સાવ જુદી પડે છે. આ શૈલીનાં મંદિરોનાં શિખરો પગથિયાંવાળાં શૂર્પાકાર (પિરામિડ) ઘાટની ટોડા (corbel) પદ્ધતિએ બાંધેલા હોય છે. તેમાં નીચેથી ઉપર જતાં ક્રમે ક્રમે ઓછી લંબાઈ-પહોળાઈ ધરાવતા **સમતલ** થરો (horizontal-fiers) વડે છેક ઉપરની ટોચ (apex) સધાય છે. આ ટોચ પર શિખરનાં અંતિમ અંગો અનુક્રમે અમલસાર (cog-wheel) અને કલશ (cupola) મૂકવામાં આવે છે. વળી ત્રણ, ચાર, પાંચ, છ, સાત કે તેથી વધુ સંખ્યામાં આવેલા ક્રમશઃ નાના કદના સમતલ થરોને ચારે બાજુએથી પાશ્ચાત્યોએ જેમને 'ચૈત્યબારી' તરીકે ઓળખાવેલ છે, તે ઘાટનાં સુશોભનો (caitya-window ornaments) વડે અલંકૃત કરવામાં આવે છે.[૨૪] ચૈત્યબારી યા ગોખનાં સુશોભનો પણ થરોના કદના ક્રમશઃ ઘટાડાને અનુરૂપ ક્રમશઃ ઓછી સંખ્યામાં રાખવામાં આવે છે. વળી તેના

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[૨૪] ભારતીય શિલ્પ-સ્થાપત્યના સિદ્ધાંત ગ્રંથોમાં આ ચૈત્યબારી કે ચૈત્યગવાક્ષ નામાભિધાન પામી ચૂકેલું સુશોભન "હંસપૃષ્ઠી" તરીકે ઓળખાવેલ છે. ઑલ ઇંડિયા ઓરિયેન્ટલ કૉન્ફરન્સના ૨૭મા અધિવેશન (બનારસ)માં પુરાતત્ત્વ વિભાગમાં આ વિશે મેં એક પેપર, "ધી ચૈત્ય-આર્ક મોટીફ ઇન ધી ટેમ્પલ્સ ઑફ ગુજરાત" વાંચ્યું હતું તેમાં આ સુશોભન "હંસપૃષ્ઠી" હોવાનું પ્રતિપાદિત કર્યું છે. મારું આ પેપર ટૂંક સમયમાં પ્રસિદ્ધ થનાર છે.

પોલાણમાં મુખ, કમળ અને કવચિત્ મૂર્તિ મૂકી તેમને વધુ આકર્ષક બનાવવામાં આવે છે. અલંકરણમાં વળી ક્યારેક સમગ્ર શિખરની અત્યંત નાના કદની પ્રતિકૃતિઓ (replicas કે miniatures)નો ઉપયોગ કરવામાં અવે છે.

આવા સમતલ થરોથી વિભૂષિત શિખરોને સ્થાપત્યની પરિભાષામાં છાદ્ય-પ્રાસાદ (flat-roofed temples) તરીકે ઓળખવામાં આવે છે.[૨૫] ગોપના મંદિરનું શિખર દ્વિછાદ્ય છે અને તે નીચેથી ઉપર જતાં દરેક બાજુએ અનુક્રમે ૨ અને ૧ ચૈત્યબારી વડે વિભૂષિત છે.[૨૫/૧] ખીમેશ્વર મંદિર નં. ૨, જૂની ધ્રવેડનું રાજલવેજલનું મંદિર તથા શ્રીનગરનું સૂર્યમંદિર[૨૬] ત્રિછાદ્ય શિખરના આદર્શ નમૂનાઓ છે. હરસિદ્ધ ટેકરીના ઢોળાવ પરનું પ્રાચીન મંદિર[૨૬/૧] તથા ભાણસરસમૂહનું એક મંદિર [૨૬/૨] પણ ત્રિછાદ્ય છે, તેમના ત્રણે થરો અનુક્રમે ૩, ૨ અને ૧ ચૈત્યબારી સુશોભનો ધરાવે છે. બોખીરાનું ચામુંડામંદિર તથા ઓડદરમંદિર નં. ૪નાં[૨૭] શિખરો પણ ત્રિછાદ્ય છે, પરંતુ તેમનાં સમતલ છાદ્યો (થરો) પરનાં ચૈત્યબારી અલંકરણો ગૂમ થયેલાં છે. પસનાવડાના સૂર્યમંદિરના શિખરના નીચેના ત્રિછાદ્યની મધ્યમાં નીચેથી ઉપર જતાં ક્રમે ક્રમે નાના કદનાં ચૈત્યબારી અલંકરણોની મધ્યલતા પ્રયોજાયેલી છે.[૨૮] આ શિખરના ઉપલા થરો પુનરુદ્ધારના સમયના લાગે છે. વીસાવાડાનું શિવમંદિર,[૨૯] ઝામરાનું સૂર્યમંદિર, પીંડારાનું જૂનું મંદિર તથા બીલેશ્વરમંદિર નં. ૧ તથા નં. ૨,[૩૦] ચતુશ્છાદ્ય શિખરોવાળાં મંદિરો છે. તેમનાં છાદ્ય દરેક બાજુએ અનુક્રમે ૪, ૩, ૨ અને ૧ ચૈત્યબારી સુશોભનોથી વિભૂપિત છે. કલસાર[૩૧] અને બલેજનાં[૩૨] સૂર્યમંદિરો તથા પોરબંદર પાસે છાયાનું ધીંગેશ્વરમંદિર[૩૩] પણ ચતુશ્છાદ્ય હતાં. તેમનો સૌથી ઉપરનો થર નાશ પામતાં હાલ તે ત્રિછાદ્ય લાગે છે. પરંતુ છાદ્યોમાંની

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[૨૫] ગુજરાતના મંદિર-સ્થાપત્યની બીજી પરંપરા ચૌલુકય-શૈલીનાં મંદિરો તરીકે ઓળખાય છે. આ શૈલીનાં મંદિરોનો નિર્માણકાળ સોલંકી (ચૌલુકય) રાજ્યના શાસનકાળ (ઈ.સ. ૯૪૨)થી શરૂ થાય છે. આ બીજી પરંપરાનાં મંદિરો પ્રથમ પરંપરાના છાદ્યપ્રાસાદોથી બહુધા જુદાં પડી રેખાન્વિત શિખર(curvilinear spire) શૈલીને અનુસરે છે. દસમી સદીના પ્રારંભથી તેરમી સદીના અંત સુધીમાં રચાયેલાં આ શૈલીનાં મંદિરો ઉત્તરોત્તર ક્રમિક વિકાસ દર્શાવે છે; અને લાંબા સમયના સતત પરિશીલન દ્વારા ઘડાયેલી પરિપક્વ હથોટી આ શૈલીનાં મંદિરોની રચનામાં જોવામાં આવે છે.

[૨૫/૧] બર્જેશ, ઉપરોકત, પ્લેટ ૫૧; સોમપુરા, ઉપરોકત, ચિત્ર ૧.

[૨૬] સોમપુરા, ઉપરોકત, ચિત્ર નં. ૧૦.

[૨૬/૧] એજન, ચિત્ર નં. ૨૧.

[૨૬/૨] એજન, ચિત્ર નં. ૩૪.

[૨૭] એજન, ચિત્ર નં. ૩૬.

[૨૮] એજન, ચિત્ર નં. ૧૭.

[૨૯] એજન, ચિત્ર નં. ૫.

[૩૦] એજન, ચિત્ર નં. ૩૦–૩૯.

[૩૧] એજન, ચિત્ર નં. ૧૨.

[૩૨] એજન, ચિત્ર નં. ૬.

[૩૩] એજન, ચિત્રનં. ૨૬.

ચૈત્યબારીઓની ક્રમિક સંખ્યા ૪, ૩, ૨ સૌથી ઉપરનો ૧ ચૈત્યબારી અલંકરણવાળો થર નાશ પામ્યાનું સ્પષ્ટ સૂચવે છે. ઓડદરમંદિરસમૂહ પૈકીનું પૂર્વ તરફનું પ્રાચીન મંદિર, બીલેશ્વરમંદિર નં. ૭ તથા કિંદરખેડાનું સૂર્યમંદિર [૩૪] પણ ચતુશ્છાદ્ય છે. પરંતુ ચૈત્યબારી સુશોભનોનો ત્યાં જે અભાવ વર્તાય છે તે ઘણું કરીને તે નાશ પામ્યાં હોવાને કારણે હોય તેમ લાગે છે. રાણાવાવના જાડેશ્વરમંદિરનું શિખર પણ ચતુશ્છાદ્ય છે અને તેના મધ્યમાં ચૈત્યબારી સુશોભનની મધ્યલતા આવેલી છે.[૩૫]

સોનકંસારીમંદિર નં. ૧,[૩૬] જૂની ધ્રવેડનું કાલિકામંદિર[૩૭] તથા દેગામનું ચામુંડામંદિર, શ્રીનગરનાં વિંધ્યવાસિની દેવીમંદિરનાં[૩૮] શિખરો પંચછાદ્ય વડે ઢાંકેલાં છે. આ શિખરોનાં થર દરેક બાજુએ અનુક્રમે ૫, ૪, ૩, ૨, ૧ ચૈત્યબારી સુશોભનોથી અલંકૃત છે. પીંડારાનું સૂર્યમંદિર[૩૯] તથા ભાણસરમંદિર નં. ૪ [૪૦] પંચછાદ્ય શિખર ધરાવતાં હતાં, પરંતુ તેમની સૌથી ઉપરનો થર લુપ્ત થયો છે; અને કિંદરખેડાના ચામુંડામંદિરના પંચછાદ્ય શિખરના થરો પરનાં ચૈત્યબારી અલંકરણો સર્વથા લુપ્ત થયેલાં છે.

બીલેશ્વરના ષડ્છાદ્ય શિખરના સૌથી ઉપરના થરમાંના ચૈત્યબારીનાં સુશોભનો લુપ્ત થયાં છે, પરંતુ બાકીના પાંચ છાદ્યમાં દરેક બાજુએ નીચેથી ઉપર જતાં અનુક્રમે ૬, ૫, ૪, ૩, ૨ ચૈત્યબારી સુશોભનો નજરે પડે છે. વળી આ છાદ્યના છેડાની નાની નાની સમગ્ર છાદ્યશિખરની પ્રતિકૃતિઓ (replicas of miniature spire)નાં સુશોભનો વડે અલંકૃત કરેલા છે.[૪૧] ષડ્છાદ્યનું આદર્શ ઉદાહરણ સોનકંસારીનું એક પ્રાચીન મંદિર પૂરું પાડે છે.[૪૨] સોનકંસારી મંદિર નં. ૬ના શિખરના ષડ્છાદ્યની મધ્યમાં ચૈત્યબારીની લતા કે શ્રેણી આવેલી છે, અને મંદિર નં. ૮નું શિખર સપ્તછાદ્યનું બનેલું છે.

બરવાળા (સુવાન--સુવર્ણતીર્થ)ના જગન્નાથમંદિરનું શિખર નવછાદ્ય છે, અને તેની ચોતરફની મધ્યલતા ચૈત્યબારીની શ્રેણીથી અલંકૃત છે.[૪૩]

પૂર્વચૌલક્યકાલીન છાદ્યશિખર (flat-roofs spire) શૈલી અને ચૌલુક્યકાલીન રેખાન્વિત શિખર (curvilinear spire) શૈલીના વચગાળાની અવાન્તર પ્રાવસ્થા (transitional-stage)નાં નિર્દેશક શિખરોવાળાં કેટલાંક મંદિરો પણ ગુજરાતમાંથી પ્રાપ્ત થયાં છે. આ અવાન્તર પ્રાવસ્થાનાં શિખરોનો અભ્યાસ છાદ્યશિખરે ક્રમે ક્રમે રેખાન્વિત શિખર શૈલીનું સ્વરૂપ કેવી રીતે ધારણ કર્યું તે સ્પષ્ટ કરે છે.

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૩૪. એજન, ચિત્ર નં. ૩૯.
૩૫. એજન, ચિત્ર નં. ૨૦.
૩૬. એજન, ચિત્ર નં. ૪૨.
૩૭. એજન, ચિત્રા નં. ૨૮.
૩૮. એજન, ચિત્રા નં. ૧૧.
૩૯. એજન, ચિત્રા નં. ૧૩.
૪૦. એજન, ચિત્ર નં. ૩૫.
૪૧. એજન, ચિત્રા નં. ૨૫૧; કઝન્સ, ઉપરોક્ત, પ્લેટ ૩૯.
૪૨. એજન, ચિત્રા નં. ૪૧.
૪૩. એજન, ચિત્રા નં. ૮.

અવાન્તર પ્રાવસ્થાનાં શિખરોમાં પણ બે ભેદ જોવામાં આવે છે. આમાંનાં કેટલાંક શિખરોનાં ચારે પાસાં ચૈત્યબારીનાં પ્રતિરૂપ (images) સમાન જાલક અને મધ્યલતાનાં સુશોભનોથી અલંકૃત છે. વળી અહીંથી આપણને સર્વપ્રથમ શિખરોના તલદર્શનમાં ભદ્રાદિ નિર્ગમો (projcetions)નાં દર્શન થાય છે. આ અવાન્તર પ્રાવસ્થાનો આદર્શ નમૂનો સૂત્રાપાડાના સૂર્યમંદિરના શિખરમાં જોવા મળે છે. આ શિખરની રેખાઓમાં સમતલછાદ્યની સ્પષ્ટ છાયા તરવરે છે. એનું ભદ્રનિર્ગમ (central off-set) ચૈત્યબારીના રૂપાંકનનો આભાસ નિષ્પન્ન કરે છે અને તેના કોણ એટલે કે મૂલનાસિકના ભાગો સમતલ છાદ્યની ચાડી ખાતાં એકાંતરે ચૈત્યબારીનાં રૂપાંકનો અને આમલક ભાતો (Āmalaka Quoins) વડે વિભૂષિત છે.[૪૪] અખોદરનું સૂર્યમંદિર[૪૫], મીંયાણીમંદિર નં. ૨[૪૬], ભાણસરમંદિર નં. ૧, કાલાવડનું કોટેશ્વરમંદિર, ધ્રાસણવેલનું મગદેરું, ધૂમલીનું ગણેશમંદિર, નંદીશ્વરમંદિર નં. ૧, સંડેર અને થાનનાં પ્રાચીન મંદિરો તથા વઢવાણનું રાણકદેવી મંદિર[૪૭] વગેરે મંદિરોનાં શિખરો અવાન્તર પ્રાવસ્થાના પ્રથમ ભેદને પ્રતિબિંબિત કરતા કેટલાક ઉત્તમ નમૂનાઓ છે. અવાન્તર પ્રાવસ્થાનાં કેટલાંક મંદિરોનાં શિખરોની રેખાઓમાં તેની અંતિમ અવસ્થાનાં સૂચક ચિહ્નોરૂપે જાલક રૂપાંકનોનો સાવ અભાવ જણાય છે. વીસાવાડાનું રાંદલમંદિર,[૪૮] નંદીશ્વરમંદિર નં. ૩ અને ૫, ઓડદરમંદિર નં. ૬, ધ્રાસણવેલનું કાલિકામંદિર,[૪૯] વસાઈ પાસેના કાંકેશ્વર[૫૦]મંદિરસમૂહ પૈકીનાં મંદિર નં. ૮, ૯, ૧૦; મીંયાણી[૫૧]નાં મંદિરો પૈકીનાં મંદિરો નં. ૧, ૩ અને ૪ તથા પંચાયતનમંદિર; પાસ્થરનું પંચાયતનમંદિર[૫૨] સોનકંસારીમંદિર નં. ૩, બીલેશ્વરનું શિવમંદિર અને પ્રાચીનું ભીમદેવલ વગેરે મંદિરોનાં અવાન્તર પ્રાવસ્થાનાં શિખરોમાં જાલક રૂપાંકનોનો અભાવ પ્રવર્તે છે. બૌદ્ધ ચૈત્યગૃહો અને દક્ષિણના પલ્લવકાલીન શૈવમંદિરો (rock-cut Temples)ના નળાકાર ઘાટના છાવણના ઘાટને મળતું ખીમેશ્વરમંદિર નં. ૬નું વલભી પ્રકારનું શિખર (gable-roofed spire) પણ તેની પ્રાચીનતાનું સૂચક છે. સમગ્ર ગુજરાતમાં આ ઘાટનો આ એક જ ઉપલબ્ધ નમૂનો છે.

પૂર્વચૌલુક્યકાલીન તેમ જ અવાન્તર પ્રાવસ્થાનાં તમામ મંદિરોનાં શિખરોની ટોચ આમલક તથા કલશ વડે વિભૂષિત કરેલી હોય છે.

પૂર્વચૌલુક્ય શૈલીનાં આ મંદિરો પૈકીનાં કેટલાંક મંદિરોના મંડપો માત્ર ભીંતાસ્તંભો (pilasters)થી વિભૂષિત છે. પસનાવડાનું ગાયત્રીમંદિર, સૂત્રાપાડાનું નવદુર્ગામંદિર, નાવદ્રાનું

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૪૪. એજન, ચિત્ર નં. ૩ અને ૨૫૨.
૪૫. એજન, ચિત્ર નં. ૧૫, ૧૬.
૪૬. એજન, ચિત્ર નં. ૨૧, ૨૨.
૪૭. એજન, ચિત્ર નં. ૧૩૩.
૪૮. એજન, ચિત્ર નં. ૪.
૪૯. એજન, ચિત્ર નં. ૨૭.
૫૦. એજન, ચિત્ર નં. ૧૦૭/એ.
૫૧. એજન, ચિત્ર નં. ૨૩/એ.
૫૨. એજન, ચિત્ર નં. ૨૪.

કાલિકામંદિર, ભાણસરમંદિર નં. ૩, બલેજ પીઠડમાતામંદિર, ખીમેશ્વરમંદિર નં. ૧ તથા ૨; સોનકંસારીમંદિર નં. ૧, કુછડીનું શિવમંદિર, બોખીરાનું ચામુંડામંદિર વગેરે મંદિરોનાં મંડપો માત્ર ભીંતાસ્તંભો પર ટેકવેલા છે. આમાં ભાણસરનાં મંદિરમાં ૮, પસનાવડા ગાયત્રીમંદિરમાં ૧૦ તથા સૂત્રાપાડાના નવદુર્ગામંદિરમાં ૧૨ ભીંતાસ્તંભો છે. બાકીનાં મંદિરો ૪ ભીંતાસ્તંભો પર ટેકવેલાં છે.

કેટલાંક મંદિરોમાં ભીંતાસ્તંભો ઉપરાંત મંડપમાં છૂટા સ્તંભો (free-standing pillars)ની રચના જોવામાં આવે છે. પસનાવડાના નાગ તથા સૂર્યમંદિરમાં ૧૦ ભીંતાસ્તંભો, રાણાવાવ જાડેશ્વરમંદિરમાં ૨ ભીંતાસ્તંભો, વીસાવાડાના રાંદલમંદિરમાં ૬ ભીંતાસ્તંભો અને આ દરેકના મંડપમાં છૂટા સ્તંભોની સંખ્યા ૨ની છે.

પૂર્વચૌલુક્ય શૈલીનાં ઘણાં મંદિરોની મધ્યમાં ૪ છૂટા સ્તંભો અને ૧૨ ભીંતાસ્તંભોની યોજના જોવામાં આવે છે. શ્રીનગરનું વિંધ્યવાસીની દેવીમંદિર, ખીમેશ્વરનું મુખ્ય મંદિર, બરવાળાનું જગન્નાથમંદિર, ધ્રાસણવેલનું મગદેરું તથા પાતાના સૂર્યમંદિરના મંડપો આ પ્રકારની રચનાનાં ઉદાહરણો છે.

સૂત્રાપાડાના સૂર્યમંદિરનો મંડપ માત્ર મધ્યના ચાર છૂટા સ્તંભો પર ટેકવેલો છે અને તેમાં ભીંતાસ્તંભોનો સાવ અભાવ છે. તેવી જ રચના ખીમેશ્વરના વલભી છાવણવાળા મંદિરના મંડપમાં જોવામાં આવે છે. બલેજના કોઠમંદિર, કુછડી તથા દેગામના ચામુંડામંદિર તથા ખીમેશ્વરમંદિર નં. ૬ના મંડપોમાં પણ આવી જ રચના છે. કદવારના વરાહમંદિરના મંડપમાં ૬ સ્તંભો અને ૨ ભીંતાસ્તંભો છે, પરંતુ મંડપના ખૂણા પર કાટખૂણે આવેલ પાર્શ્વચોકીઓ વામનકદના સ્તંભો (dwarf pillars) પર ટેકવેલી છે. નવી ધ્રવેડના કાલિકામંદિરનો મંડપ ૪ ભીંતાસ્તંભો પર છે, પરંતુ મંડપની બન્ને બાજુના દંડછાદ્ય (eave)થી વિભૂષિત ઝરૂખાઓ (balconies)માં બે બે વામન સ્તંભો છે. ધ્રાસણવેલના કાલિકામંદિરનો મંડપ ચાર સ્તંભો પર ટેકવેલો છે, પરંતુ તેના પ્રવેશદ્વારનાં બન્ને બાજુએ બે સ્તંભોની યોજના છે, તેમ જ મંડપની પશ્ચિમ દીવાલે બે ઝરૂખા અને ઉત્તર અને દક્ષિણ બાજુની દીવાલમાં એક એક ઝરૂખો છે. ઉપરોક્ત બધાં જ મંદિરોના મંડપના સ્તંભો બહુધા ચોરસ ઘાટના છે. સ્થાપત્યની પરિભાષામાં આ ઘાટના સ્તંભોને ‘રુચક’ સ્તંભો તરીકે ઓળખાવેલા છે. જે સ્તંભોની ચારે બાજુએ મધ્યમાં ભદ્રનિર્ગમની યોજના હોય છે તે પ્રકારના સ્તંભોને સ્થાપત્યની પરિભાષામાં ‘ભદ્રક’ સંજ્ઞા આપવામાં આવી છે. આવા સ્તંભો પીંડારાના પ્રાચીન મંદિરના તથા ધ્રાસણવેલના મગદેરાના મંડપમાં જોવામાં આવે છે. પસનાવડાના ગાયત્રીમંદિરના ભીંતાસ્તંભોનો દર્શનીય ભાગ ‘ભદ્રક’ પ્રકારનો છે. પસનાવડાના સૂર્યમંદિરના મંડપના સ્તંભો કોઈ એક જ પ્રકારના નથી. ખીમેશ્વરમંદિર નં. ૧ના મંડપના સ્તંભો નીચેના છેડે ચોરસ અને ઉપરના ભાગે અષ્ટકોણીય (અષ્ટભદ્રી–octagonal) હોવાને કારણે સ્તંભ આયોજનનું મિશ્ર સ્વરૂપ (composite shape) પ્રકટ કરે છે.

પૂર્વચૌલુક્ય શૈલીનાં મંદિરોની શૃંગારચોકીઓનું સ્તંભવિધાન પણ સાદું છે. મીંયાણી અને કુછડીનાં શિવમંદિરો તથા શ્રીનગરનાં સૂર્યમંદિરની શૃંગારચોકીઓમાં ૨ ભીંતાસ્તંભો અને

બે છૂટા સ્તંભો આવેલા છે. મીંયાણીના બીજા એક પ્રાચીન શિવમંદિરની શૃંગારચોકીમાં બબે યુગલ ભીંતાસ્તંભો (pilasters in a pair) અને યુગલ છૂટા સ્તંભોની વિશિષ્ટ રચના છે. આ શૈલીનાં કેટલાંક મંદિરોની શૃંગારચોકીઓ ત્રિક્-ચોકી (ત્રિ-ચોકી) (Porch having three-compartments)ની રચના ધરાવે છે. શ્રીનગરના વિંધ્યવાસીની દેવીમંદિર, ખીમેશ્વરના મુખ્ય મંદિર, બરવાળાના જગન્નાથ મંદિર તથા બલેજના સૂર્યમંદિરની શૃંગારચોકીઓ આ પ્રકારની છે અને તે દરેકમાં અગ્ર ભાગે બબે છૂટા સ્તંભો અને પૃષ્ઠ ભાગે છ છ ભીંતાસ્તંભોની યોજના છે. અપવાદરૂપે ખીમેશ્વરમંદિરસમૂહ પૈકીનાં ધીંગેશ્વરમંદિરની ત્રિક્-ચોકીમાં ચાર ભીંતાસ્તંભો છે, તો નવી ધ્રવેડના કાલિકામંદિરની શૃંગારચોકી બે ભીંતાસ્તંભો અને અગ્ર ભાગે ચાર છૂટા સ્તંભો આવેલા છે. આ શૈલીનાં કેટલાંક મંદિરોની શૃંગારચોકીઓ વળી કક્ષાસન (sloping-seat) અને વેદિકા (dwarf wall)થી અલંકૃત કરેલી જોવામાં આવે છે. દા.ત., કિંદરખેડાના રાંદલ-મંદિરની શૃંગારચોકી ૪ ‘રુચક’ પ્રકારના વામન સ્તંભોથી વિભૂષિત છે. કદવારના વરાહમંદિરમાં કક્ષાસનયુકત શૃંગારચોકીઓ છે. ઓડદરમંદિર નં. ૬ (વિષ્ણુમંદિર)ની શૃંગારચોકીના સ્તંભો ‘ભદ્રક’ પ્રકારના છે.

પૂર્વચૌલુકય શૈલીનાં મંદિરોનાં મંડપો, શૃંગારચોકીઓ તથા પ્રદક્ષિણાપથ મોટે ભાગે સપાટ છાવણ (પિઢાન ફલક--flat roof) વડે ઢાંકેલા હોય છે. કેટલેક સ્થળે આ છાવણ કે આચ્છાદન છાપરાની માફક ઢાળ પડતું રાખવામાં આવેલું છે. વળી ઘણી વાર ઢાળ પડતા છાવણ પર એક બીજો થર (layer) ચઢાવવામાં આવે છે જેથી તેનો સમગ્ર ઘાટ પગથિયાવાળા ઘાટના છાપરા જેવો બને છે. વળી આ સંજોગોમાં તે પર ચૈત્યબારીનાં સુશોભનો પણ અંકિત કરવામાં આવે છે. એક પર એક આવા ચાર થરોથી વિભૂષિત મંડપ-આચ્છાદન સોનકંસારી નં. ૬ના મંદિર પર જોવામાં આવે છે.[૫૩] આ પ્રકારની પગથિયાળી ઢાળવાળી રચનાને સ્થાપત્યની પરિભાષામાં ‘ફાંસના પિઢાન ફલકા’ કહેવામાં આવે છે. ધ્રાસણવેલના કાલિકામંદિરની પ્રદક્ષિણાપથની રચના બેવડા થરવાળા આવા ફાંસના પિઢાન ફલકાની છે. પાતાના સૂર્યમંદિર અને બોરિચાન' ચામુંડામંદિરના મંડપો પણ આ જ રીતે આચ્છાદિત કરેલા છે. પસનાવડાના ગાયત્રીમંદિરના મંડપ પર ફાંસના પિઢાનની રચના છે પણ તેની અંદરની છત ચૌલુકય સમયમાં ઘણી જાણીતી થયેલ ‘કરોટક’ (hemispherical dome) રચનાને મળતી છે. તેની મધ્યમાં ‘પદ્મશિલા’ (pendant) પણ છે. આ રચના પાછલા સમયના પુનર્નિમાણ કાલની હોવાની સંભાવના છે, કારણ કે મંડપના છાવણનો બાહ્ય ઉપલો ભાગ ફાંસના પિઢાન ફલકો વડે ઢાંકેલો છે અને તે સાત થરોનો બનેલો છે એટલું જ નહીં, પણ તેનો દરેક થર ચૈત્ય સુશોભનો વડે અલંકૃત કરેલો છે.

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[૫૩] સોમપુરા, ઉપરોક્ત, ચિત્ર નં. ૪૨.

STANDARDIZATION OF A TEST OF PERCEPTUAL SPEED AND ACCURACY

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Introductory :

Analysis of a number of clerical jobs has revealed two important characteristics in the duties of clerks : (1) speed in checking numerical and verbal symbols, and (2) accuracy in checking. Typewriting, comparing, record-keeping, book-keeping, and such other duties of clerks call for a good perceptual speed and accuracy on the part of the worker. (Super and Crites, 1962, p. 160). Cashiers, booking office clerks in railway, state transport, cinema theatres and such other concerns also need to have high perceptual speed and accuracy in taking out appropriate tickets and counting their value. Many clerical workers use tables or ready-reckoners and in referring to them quickly they must have a good perceptual speed and accuracy. Proof-readers must also possess good perceptual speed and accuracy in doing their job efficiently. Managers, administrators, auditors, chartered accountants and such other professional workers should also possess high degree of clerical ability, chiefly perceptual speed and accuracy.

In addition to these two abilities, clerical workers need to possess a fair degree of intelligence, motor skill or manual dexterity, verbal ability and number ability. Different types of clerical work need all or some of these abilities in various proportions (Bingham, 1937, p. 152). It is, therefore, difficult to recognize the group of abilities involved in different types of clerical work as clerical aptitude, although some test-makers have named their tests as tests of clerical aptitude. (Super and Crites, 1962, p. 161).

Minnesota Clerical Test :

As part of the great project on test construction carried out at the Minnesota Employment Stabilization Research Institute during the thirtees, this test was devised under the name of Minnesota Vocational Test for Clerical workers which was later changed to its present title—Minnesota Clerical Test. It includes two sub-tests : (1) Number comparison and (2) Name comparison. It was designed for adult use, but norms for boys and girls of high school age were also prepared in addition to those for clerical workers in general, gainfully employed adults and various specific clerical occupations, such as shipping clerks, routine clerical workers, bank tellers and accountants and book-keepers. (Bennet, 1959).

Desai Speed and Accuracy Test

Construction :

The present writer constructed a test for assessing the perceptual speed and accuracy on the lines of the Minnesota Clerical Test. The Minnesota test could not be adapted directly as it was no use translating the names of American people and of American shops and companies, they being very foreign to our young boys and girls. The Number test could have directly been used changing it into Gujarati script, but it was thought desirable to prepare a new one on the same lines.

200 pairs of numbers, half of which are similar and half of which have one digit less or dissimilar were coined for the Number test. These numbers have a span of three to twelve digits. The subject has to put a √ tick mark between the pairs of exactly similar numbers. He has to do this type of checking as quickly as he can. The following are a few examples :

૫૫૩૭————૫૫૨૭
૪૩૦૧૨——√——૪૩૦૧૨
૨૧૮૬૨૨૪૬૫૧૦૨——√——૨૧૮૬૨૨૪૬૫૧૦૨
૫૭૫૯૭૬૩૨૫————૫૭૬૯૭૬૩૨૫

For the Name comparison test 200 pairs of names of Gujarati men and women and of Gujarati shops and companies were coined. 100 pairs had similar names and 100 had dissimilar names. The dissimilar pairs had only one letter different in them. The following are a few examples :

મુકુંદ દલાલની કં.—√—મુકુંદ દલાલની કં.
સુદેવી દિનુભાઈ મહેતા———સુદેવી વિનુભાઈ મહેતા
ગાંધી ખાદી મંદિર, વડોદરા———ગાંધી ખાદી મંદિર, કડોદરા
પ્રકાશ હાઈસ્કૂલ—√—પ્રકાશ હાઈસ્કૂલ

It was thought advisable not to introduce dissimilarity because of અનુસ્વાર and

હ્રસ્વ or દીર્ઘ ઉ or ઊ. All other types of dissimilarities were used. In the Minnesota test, Kirkpatrick (1957) observed a defect that the dissimilar element occurs in the latter half of the numbers in 77% of the items in the Number test, so that if some subject reads the numbers from the end, he would save time. Desai test does not have any such defect and the dissimilarities are evenly distributed in both the numbers and names.

Since the nature of all the items is similar and since this is essentially a test of speed, it was not necessary to carry out item analysis as in other types of psychological tests. The Minnesota test was also not subjected to the traditional type of item validation. In this type of tests, the validation of the entire test is automatically the validation of each item and each item has the same difficulty value. For these reasons, the test was not subjected to item validation and the difficulty values of the items were also not determined.

The test has been printed on a single sheet of paper and the paper is folded in a special manner. The title page remains above, turning which two pages of the Number test appear. Then, when the second page of the number test is turned, instruction for being ready for the second test appears. When that page is turned again, the two pages of the Name test are there before the subject. Lastly, when the second page of this test is turned, the title page appears again.

The Norm Groups :

The main purpose of standardizing this test was to prepare a tool for guidance purposes. It was not aimed simply to make it a clerical aptitude test since what is thought to be clerical aptitude is composed of a number of specific abilities. Since perceptual speed is the main element of this test and since it is one of the composite abilities in clerical aptitude, it was more advisable to call it simply a speed and accuracy test. It will thus serve many more purposes than merely testing clerical aptitude. It will be applicable to all situations where speed and accuracy are involved.

The main norm group, therefore, was chosen from high school pupils of Gujarat. For comparison, a small group of students reading for their Government Commercial Diploma examination was also chosen. Moreover a group of clerks working in a textile mill were administered the test.

The following table shows the description of the norm groups :

Table 1 : Description of the Norm Groups

Group	*Male*	*Female*	*Total*
Pupils of Std. VIII	174	66	240
Pupils of Std. IX	388	82	470
Pupils of Std. X	400	50	450
Pupils of Std. XI	267	40	307
Students of Government Commercial Diploma	20	..	20
Clerks of a Textile Mill	34	..	34

The tests were first administered to equal number of classes of Std. VIII, IX, X and XI of urban, rural and semi-urban schools of Gujarat, thus taking equal samples of pupils in the four grades. It was, however, observed that among Std. VIII pupils there were some boys and girls whose age was less than 13 or more than 14, 13 and 14 being the modal ages for this grade. Similarly there were some boys and girls in the sample of Std. XI pupils who were younger than 15 or older than 17 years, 16 and 17 being the modal ages for this grade.

Inclusion of younger and older pupils in the norm group would vitiate the norms and therefore such pupils were weeded out. The remaining pupils have been included in the norm groups. Although they make unequal samples of different grades, their number does not make any material change, since it was decided to fix up grade norms and not age norms.

Administration and Scoring :

Necessary instructions are printed on the title page of the booklet for the administration of the tests. They are to be explained fully to the subjects. It is particularly to be pointed out that this being a test of speed and accuracy both are to be paid attention to and not either of the two. Four illustrations of the two types of sub-tests are printed on the title page which are also to be explained with particular reference to the dissimilarities wherever they are.

The test is then to be administered with a time-limit of eight minutes for each of the two sub-tests. The first test to be given is Number Comparison Test and after its eight minutes are over the subjects turn over the page and take a little pause. Then the second test is to be given.

Stencils of correct answers can be prepared for assessing the answer. Correct and incorrect responses are to be totalled and entered on the table on the title page. The score is determined by the formula R–W to keep out guessing. Both the tests are to be scored separately.

Evaluation :

Medians of scores of each norm group are calculated. A ready-reckoner of percentiles from scores is prepared with the help of which the individual subject's percentile rank or standing in a group of hundred can be found out. PRs. of an individual can be read out from the ready-reckoner as per all different norm groups.

The following table shows the norms on different samples :

Table 2 : Norms

Norm Group	N	*Number Comparison*			*Name Comparison*		
		Q_1	Q_2	Q_3	Q_1	Q_2	Q_3
Std. VIII Boys	174	78	92	106	62	80	93
Girls	66	87	105	112	71	92	105
Std. IX Boys	388	78	94	114	69	81	99
Girls	82	89	110	124	76	100	114
Std. X Boys	400	87	105	124	77	94	108
Girls	50	101	120	136	87	104	121
Std. XI Boys	267	101	118	142	87	107	129
Girls	40	109	131	153	97	124	149
Govt. Commercial Diploma Students	20	122	147	160	89	122	151
Clerks of a Textile Mill	34	95	117	147	75	105	135

Observations :

A perusal of the norms given in Table 2 bring out the following points :

(1) *Sex Difference* is remarkable in the norms of all school grades. Girls are found to be superior to boys on this test. The difference is quite big and does not need application of test for significance. Similar results have been obtained in the Minnesota Clerical Test (Andrew and Paterson, 1934 Englehardt, 1950; Schneidler and Paterson, 1942). Sex difference in favour of girls has also been observed in the Clerical Speed and Accuracy Test of the Differential Aptitude Tests (Bennet, Seashore and Wesman, 1959) and the General Clerical Test of the Psychological Corporation.

(2) *Age and Grade Standing* also seem to influence the scores on this test. The higher grades show higher norms and since the age is represented in grade standing, scores seem to be increasing with age, so far as the school-sample is concerned. The same result has been obtained in other clerical tests referred to above.

(3) Students of Government Commercial Diploma show higher norms than ordinary high school students of the same age and grade. It seems those who have selected clerical work as career are better on this test than pupils in general.

(4) Clerks working in a textile mill show lower norms than the XI grade pupils but higher than the X grade pupils. Their norms are, of course, much lower than those of the students of Government Commercial Diploma. This strange result may be due to the biased sample of clerks, since it did not represent clerks in general.

Reliability :

The reliability of the two sub-tests was found by test-retest method, by split-half method and by Kuder-Richardson formula. The test-retest reliability was determined on homogeneous samples of four school grades severally and also on their combined sample administering the test again after six months.

The following table shows the reliability coefficients obtained by the three methods :

Table 3 : Reliability Coefficients

Method	*Sample*	*N*			*Number Test*		*Name Test*	
		Boys	*Girls*	*Total*	*r*	SE_r	*r*	SE_r
Test-Retest (Interval : six months)	Std. VIII	26	12	38	.81	.04	.88	.03
	Std. IX	21	19	40	.92	.02	.77	.06
	Std. X	11	29	40	.80	.05	.84	.04
	Std. XI	32	11	43	.66	.08	.67	.08
	All grades combined.	90	71	161	.85	.02	.87	.02
Split-half	,,	50	50	100	.99	.006	.99	.006
Kuder-Richardson	,,	50	50	100	.83	.02	.87	.02

The test-retest reliability varies from .66 to .92 in homogeneous groups and is .85 and .87 in the heterogeneous group. It is remarkable that the Name test shows a little greater reliability than the Number test with only one exception. The corrected split-half reliability is almost perfect and the reliability calculated by Kuder-Richardson formula is also very high.

All reliability coefficients obtained on this test are higher than those reported on the Minnesota Clerical Test. In the latter test, the split-half reliability was found to be .85 and .89 and test-retest reliability ranged from .56 to .81 (Super and Crites, 1962, p. 171).

Validity :

The validity of the test was determined by correlating the Number test with the Name test on a sample of 230 drawn equally from all the four high school grades. The coefficient of correlation came to be .73 with SE_r of .03.

This correlation between the two sub-tests is lower than the reliability coefficients of both the tests. This indicates that one of the two tests measures something not so well measured by the other. A similar result was also seen in the case of the Minnesota test. (Supper and Crites, 1962, p. 168). It was found to be due to higher correlation of Name test with intelligence.

In the present test, therefore, correlation of the two sub-tests was obtained on a sample of 135 composed of all four school grades with Desai-Bhatt Group Test of Intelligence which is verbal in nature. It came to be .35 with SE_r .08 for the Number test and .50 with SE_r .06 for the Name test. This corroborates the view that the higher correlation of the latter with intelligence is responsible for the inter-sub-test correlation.

Thus intelligence is found to be influencing perceptual speed and accuracy.

Applicability:

This test is designed to measure the perceptual speed and accuracy, very useful in clerical and allied jobs and can be used with high school pupils and adults. It will be very useful in guidance of students and also in selecting better persons for clerical jobs. The tests and the manual of directions are published by the author himself and can be had from him on demand.

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CONSTRUCTION AND STANDARDISATION OF THE FAMILY AND SOCIAL ADJUSTMENT INVENTORIES*

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SUMMARY

The main purpose of the present attempt was the construction and standardisation of the family and social adjustment inventories in Gujarati. Both the inventories are intended to be used with high school and college students for counselling and research. They are self-administering. The family adjustment inventory and the social adjustment inventory have been standardised on samples of 3,273 and 2,912 male and female students, selected from some of the districts of the State of Gujarat. Both are provided with norms based on standard deviation units. They showed satisfactory reliability and validity against several criteria. They can be used with caution with special groups. The work of further validation of both the inventories against the interview data is in progress.

Introduction :

Recently, as a result of guidance movement in India and especially in the State of Gujarat, several guidance centers have been established at governmental and institutional levels. Different universities in the State of Gujarat have also started post-graduate programmes in guidance and counselling to meet with the needs of trained personnel. Further, a strong need is expressed by several workers in these areas at different levels concerning psychological tests for

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guidance and counselling purposes. Just to meet with this need, an humble effort has been made here to construct and standardise the family and social adjustment inventories for high school and college students of both sexes.

Purpose :

The main purpose of the present inventories was to provide tools for measuring family and social adjustment for guidance and counselling of the students. Further. both these inventories can also be conveniently used for research purpose. It is hoped that they will be usefull to teachers, councellors, social workers and researchers.

Description :

The present inventories provide two separate comparable measures of family and social adjustments. Each consists of 40 items. The individual is required to respond to each item in both the inventories by encircling any one of the three alternatives — 'Y'. '?' and 'N' — given at the end of the item. There is no time limit for completing either inventory. Each would ordinarily take about fifteen minutes for the subject to complete. They are self-administering. All the required directions are given in the beginning. Like other personality inventories, it would require a good rapport between the person administering and the person taking them. In each case scoring can be done in accordance with the key provided in the manual. The responses given to the '?' question mark are not to be counted. A higher score indicates good adjustment and a low score indicates poor adjustment. The raw scores are to be converted into T – scores.

Item selection

Pool of items :

All the statements indicating family and social adjustment were collected from various sources such as students' free writings, group discussions among the students, interviewing the several students, inventories—foreign and Indian—and relevant literature. On the basis of the information collected, several items were prepared to suit the adjustment inventories. All the items were edited by a panel of five experts for their face validity. The experts were also asked to give their comments regarding the structure, language and expression on each item. All the items were also presented to a group of male and female students with a view to finding out ambiguity and removing them.

Preliminary try-out :

Thus, the preliminary forms of both the inventories, with necessary instructions were administered to a group of about two hundred male and female senior high school students. They were administered in small groups. Respondents were asked to give their comments on any item or items and on the total inventory in both the cases. Consequently, all the ambiguous, double barrelled and mis-leading items were eliminated.

Item analysis :

Ninety two items in family adjustment and seventy five items in social adjustment inventory were subjected to statistical analysis. For determining the discrimination power, and internal consistency of each item, both the inventories were separately given to a group of approximately 350 high school and college students of both the sexes. Only forty items in each case were selected for final administration.

Final Administration :

For the standardisation purpose, the family adjustment inventory was administered to a group of 3,273 and social adjustment inventory was administered to a group of 2,972 males and females. The said samples were separately drawn from some of the districts of the State of Gujarat — Surat, Ahmedabad, Panchmahals, Mehsana, Surendranagar, Rajkot and Bhuj. In both the cases samples represented urban, semi-urban and rural high schools and colleges especially Arts, Science and Commerce.

Norms

For facilitating the comparison, the norms are given in T-scores. Any raw score can be converted into T-score.

Table number 1 : Norms based on SD units

Sr. No.	*Category*	*Family*	*Social*
1	Excellent adjustment	55 or more	67 or more
2	Good adjustment	44 to 54	56 to 66
3	Satisfactory adjustment	34 to 43	40 to 55
4	Unsatisfactory adjustment	27 to 33	29 to 39
5	Poor adjustment	26 or less	28 or less

Table number 1 gives separate norms based on standard deviation units on a five point-scale for both the inventories. In each case the obtained T-score can be interpreted with the help of the given norms.

Reliability and Validity :

The reliability was determined for both the inventories using test-retest and split-half methods.

Table number 2 : Reliability Coefficients

Sr. No.	*Method*	*Coefficients of reliability* *Family*	 *Social*	 *N*
1	Test-retest	.82	.85	109
2	Split-half corrected with Spearman-Brown Prophecy Formula	.87	.90	126

Table number 2 gives the reliability coefficients for both the inventories The reliability coefficients for test – retest method and split-half method corrected with Spearman-Brown prophecy formula were .82 and .87 in case of family adjustment inventory and .85 and .90 in case of social adjustment inventory. Thus, they showed fairly good reliability.

The family adjustment inventory was correlated with Dr. A. S. Patel's Kutumb Sumela Mapsuchi, and it has given a validity coefficient of .61 on a sample of 75 senior high school students of both the sexes.

Both the inventories — family and social — have been validated against the criterion of teachers' estimates of family and social adjustment of their students of both the sexes. It gave a validity coefficients of .59 and .65 separately for family and social adjustment inventories respectively.

The significant differences between the means of delinquents and normals were found for family and social adjustment inventories. The critical ratio values were 6.59 and 10.72 for family and social adjustment inventories respetively.

The procedure for validitation of both the inventories against interview data is in progress.

Limitations :

The present inventories have been devised for studying normal school or college going population of both sexes. So they should not be used for studying groups with special handicaps or deviations such as the physically handicapped, blind, criminals, etc.

Suggestions :

An attempt could be made for construction and standardisation of the inventories for measuring school, health, emotional and occupational adjustments.

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કૌટુંબિક સમાયોજન સંશોધનિકા[c]

FAMILY ADJUSTMENT INVENTORY

— સૂચના —

(૧) પ્રસ્તુત સંશોધનિકાનો મુખ્ય ઉદ્દેશ વ્યકિતનું કૌટુંબિક સમાયોજન તપાસવાનો છે. સંશોધનિકામાં વ્યકિતના કુટુંબજીવનને સ્પર્શતા કેટલાક પ્રશ્નો આપ્યા છે. તમારે પ્રત્યેક પ્રશ્ન કાળજીપૂર્વક વાંચી-વિચારીને પ્રામાણિકપણે તેના યોગ્ય જવાબો આપવાના છે.

(૨) આ પરીક્ષા કે બુદ્ધિકસોટી નથી. પ્રશ્નોના સાચા કે ખોટા જવાબો નથી. દરેક પ્રશ્નનું પોતાનું વિશિષ્ટ મહત્ત્વ છે. જવાબ આપતાં પહેલાં પ્રત્યેક પ્રશ્ન વાંચો અને તમારો જે જવાબ હોય તે પ્રમાણે તેની સામે આપેલા "હા" કે "ના" ઉપર ગોળ "○" કરો. જો તમે "હા" કે "ના"માંથી કોઈ પણ જવાબ આપી શકો તેમ ન હો તો પ્રશ્નાર્થ "?" ચિહ્ન ઉપર ગોળ "○" કરો,

(૩) ઉદાહરણ— (૧) તમારા ઘરના સભ્યો વચ્ચે સારો મેળ છે એમ તમને લાગે છે? [✓ હા] ? ના

(૨) તમારી સાથે તમને ન ગમતી વ્યકિત રહે છે? હા ? [✓ ના]

સંશોધનિકા લેનાર એક વ્યકિતને પહેલા જવાબમાં હા હોવાથી "હા" ઉપર ગોળ "○" કર્યું અને બીજા પ્રશ્નના જવાબમાં "ના" હોવાથી "ના" ઉપર ગોળ "○" કર્યું.

(૪) અહીં તમે જે માહિતી આપશો તે ખાનગી રાખવામાં આવશે. માટે ધ્યાનપૂર્વક એક પછી એક પ્રશ્ન વાંચી તેના પ્રામાણિકપણે બતાવ્યા મુજબ જવાબ નોંધો.

હવે શરૂ કરો

૧. તમારી કોઈ ટેવ તમારાં માતા-પિતા અથવા તમારી સાથે રહેતી કોઈ વ્યકિતને ઉશ્કેર્યા કરે છે? હા ? ના

૨. તમારી પ્રવૃત્તિઓ ઉપર તમારા ઘરની કોઈ વ્યકિત છાની નજર રાખ્યા કરે છે એમ તમને લાગે છે? હા ? ના

૩. તમને એમ લાગે છે કે તમારા ઘરમાં તમને વ્યકિતત્વ-વિકાસ માટે પૂરતી તકો મળી રહે છે? હા ? ના

૪. તમારાં માતાપિતા સાથે અભ્યાસની બાબતમાં તમને મતભેદ પડે છે? હા ? ન

૫. તમારાં માતાપિતા તમારા તરફ હમેશાં યોગ્ય વર્તાવ રાખે છે એમ તમને લાગે છે? હા ? ના

૬. તમારે માટે તમારું કુટુંબ અભિમાન લે છે? હા ? ના

૭. તમારાં માતાપિતાનો સ્વભાવ સામાન્ય રીતે પ્રફુલ્લિત રહ્યા કરે છે? હા ? ના

૮. તમને લાગે છે કે તમારાં માતાપિતા તમારે માટે નિરાશ થતાં હોય છે? હા ? ના

૯. તમારા ઘરમાં તમારી કોઈ ઈર્ષા કે દેખાદેખી કરતું હોય એમ તમને લાગે છે? હા ? ના

૧૦. તમને ઘરમાંથી જોઈતાં સ્નેહ અથવા હૂંફ મળી રહે છે? હા ? ના

૧૧. તમારા ઘરમાં વિચારો અંગે વારંવાર પરસ્પર તીવ્ર મતભેદ પડયા કરે છે? હા ? ના

૧૨. તમને લાગે છે કે તમારા ઘરની આર્થિક સ્થિતિને લઈને તમારે વેઠવું પડે છે? હા ? ના

૧૩. તમે તમારા ઘરમાં રેડિયો કે વાજિંત્રો જેવાં સાધનો ગમે ત્યારે વગાડી શકો છો? હા ? ના

૧૪. કોઈ વસ્તુ જોઈતી હોય અથવા કયાંય જવું હોય ત્યારે તમે તમારાં માતાપિતાને સહેલાઈથી કહી શકો છો? હા ? ના

૧૫. તમારાં માતાપિતા ચીડિયા સ્વભાવનાં છે એમ તમને લાગે છે? હા ? ના

૧૬. તમારાં માતાપિતા અભણ કે ઓછું ભણેલાં છે એમ તમને વારંવાર લાગ્યા કરે છે? હા ? ના

૧૭. તમારાં માતાપિતા તમારા દેખાવ અંગે વારંવાર ટીકા કર્યા કરે છે? હા ? ના

૧૮. પ્રસંગોપાત્ત તમારા ઘરનાં બધાં સમૂહમાં ફરવા કે આનંદ માણવા જાય છે? હા ? ના

૧૯. તમને સ્પર્શતી બાબતોમાં તમારા પિતા સંમતિ આપે, જ્યારે તમારાં માતા સંમતિ ન આપે એવું વારંવાર બને છે? હા ? ના

૨૦. તમારાં માતાપિતા કેટલીક બાબતોમાં તમારાં ભાઈ-બહેન કે બીજા કોઈ મિત્રોના દાખલા આપી તમને વારંવાર ટોકયા કરે છે? હા ? ના

૨૧. તમારા ઘરમાં લાગણી અને હૂંફવાળું વાતાવરણ છે? હા ? ના

૨૨. તમને એમ લાગે છે કે તમારાં માતાપિતા જૂના વિચારનાં હોવાથી તેમની સાથે તમારે વારંવાર સંઘર્ષ થયા કરે છે? હા ? ના

૨૩. તમારાં માતાપિતા તમારાં ભાઈ કે બહેન તરફ પક્ષપાત કરે છે એ તમને થયા કરે છે? હા ? ના

૨૪. તમારાં માતાપિતાને એમ લાગે છે કે તમે તેમને માટે પૂરતો વિચાર કરો છો? હા ? ના

૨૫. તમે તમારાં માતાપિતા સાથે તમારી મૂંઝવણો છૂટથી ચર્ચી શકો છો? હા ? ના

૨૬. તમને લાગે છે કે તમને ઘરમાં અવગણવામાં આવે છે? હા ? ના

૨૭. તમને એમ લાગે છે કે તમારાં માતા અથવા પિતા વહેમી સ્વભાવનાં છે? હા ? ના

૨૮. તમને શાંતિ માટે ઘરથી દૂર જવાનું વારંવાર મન થઈ જાય છે? હા ? ના

૨૯. તમારાં માતાપિતા તમારી સાથે નિરર્થક સખતાઈ કરતાં હોય એમ લાગે છે? હા ? ના

૩૦. તમારા ઘરનું વાતાવરણ તમને સુખી અને સંતોષી લાગે છે? હા ? ના

૩૧. તમને લાગે છે કે તમારા ઘરમાં તમે હજુ બાળક હો તેમ સમજી તમારી સાથે વર્તાવ કરવામાં આવે છે? હા ? ના

૩૨. તમારા મિત્રોના ઘરની સરખામણીમાં તમારા ઘરનું વાતાવરણ વધારે સુખી અને આનંદદાયક છે? હા ? ના

૩૩. તમારાં માતાપિતા વારંવાર તમારા વર્તનમાં દોષ કાઢતાં હોય એવું તમને લાગે છે? હા ? ના

૩૪. તમારાં માતાપિતા જે કરતાં હોય તેનાથી તમને ક્ષોભ થાય છે? હા ? ના

૩૫. તમારાં માતાપિતા તમને પૂરતી સ્વતંત્રતા આપે છે? હા ? ના

૩૬. તમે તમારાં માતપિતાના કારણે મિત્રોને ઘેર બોલાવતાં ખચકાઓ છો? હા ? ના

૩૭. તમે તમારી મહત્ત્વની બાબતોમાં સ્વતંત્ર રીતે નિર્ણય લઈ શકો છો? હા ? ના

૩૮. તમને તમારા ઘર કરતાં બીજે વધારે આનંદ મળે છે એમ તમને લાગે છે? હા ? ના

૩૯. તમારા ઘરમાં એકબીજાની પાછળ બધાં કૂથલી કે ચાડીચુગલી કરે છે? હા ? ના

૪૦. તમને ખિસ્સાખર્ચ માટે પૂરતા પૈસા તમારાં માતાપિતા પાસેથી મળે છે? હા ? ના

નામ: ______________________ વય: __________ તારીખ: __________

સંસ્થા: ______________________ વર્ગ: __________ જાતિ સ્ત્રી / પુરુષ: __________

સામાજિક સમાયોજન સંશોધનિકા

SOCIAL ADJUSTMENT INVENTORY[c]

—સૂચના—

(૧) પ્રસ્તુત સંશોધનિકાનો મુખ્ય ઉદ્દેશ વ્યકિતનું સામાજિક સમાયોજન નક્કી કરવાનો છે. સંશોધનિકામાં વ્યકિતના સામાજિક જીવનને સ્પર્શતા કેટલાક પ્રશ્નો આપ્યા છે. તમારે પ્રત્યેક પ્રશ્ન કાળજીપૂર્વક વાંચી-વિચારીને પ્રામાણિકપણે તેના યોગ્ય જવાબો આપવાના છે.

(૨) આ પરીક્ષા કે બુદ્ધિકસોટી નથી. પ્રશ્નોના સાચા કે ખોટા જવાબો નથી. દરેક પ્રશ્નના જવાબનું વિશિષ્ટ મહત્ત્વ છે. જવાબ આપતાં પહેલાં પ્રત્યેક પ્રશ્ન વાંચો અને તમારો જે ઉત્તર હોય તે પ્રમાણે તેની સામે આપેલા "હા" ઉપર ગોળ "○" કરો અથવા "ના" ઉપર ગોળ "○" કરો. જો કોઈ પ્રશ્નનો જવાબ તમે નક્કી કરી શકતા ન હો તો તેની સામે આપેલા "?" ચિહ્ન ઉપર ગોળ "○" કરો.

(૩) ઉદાહરણ — ૧. તમે બને ત્યાં સુધી સામૂહિક પ્રવૃત્તિમાં ભાગ લેવાનું ટાળો છો? હા ? [✓ ના]

૨. તમે અજાણી વ્યકિત સાથે તમારો સ્વયં-પરિચય આપી શકો છો? [✓ હા] ? ના

પ્રસ્તુત સંશોધનિકા લેનાર એક વ્યકિતને પહેલા પ્રશ્નના જવાબમાં ના હોવાથી "ના" ઉપર ગોળ "○" કર્યું; અને બીજા પ્રશ્નના જવાબમાં હા "હા" ઉપર ગોળ "○" કર્યું.

(૪) તમે અહીં જે માહિતી આપશો તે ખાનગી રાખવામાં આવશે, માટે ધ્યાનપૂર્વક એક પછી એક પ્રશ્ન વાંચી તેના પ્રામાણિકપણે બતાવ્યા મુજબ તમારા યોગ્ય જવાબો દર્શાવો. કોઈ પણ પ્રશ્નનો જવાબ નોંધવાનો રહી ન જાય તે ધ્યાનમાં રાખશો. પ્રસ્તુત સંશોધનિકા માટે કોઈ સમયમર્યાદા નથી. છતાં પણ તમે તમારા જવાબો ઝડપથી આપો તે ઇચ્છનીય છે.

હવે શરૂ કરો

૧. કોઈ પણ મેળાવડા કે સમારંભ કે ઉજાણીમાં તમે સહેલાઈથી ભાગ લઈ શકો છો? હા ? ના

૨. કોઈ પણ અજાણી વ્યકિત સાથે ચર્ચાનો શરૂઆત કરતાં તમે ક્ષોભ અનુભવો છો? હા ? ના

૩. સામાજિક પ્રસંગોએ તમે પાછળ રહો છો? હા ? ના

૪. કોઈ પણ મેળાવડામાં તમે આકર્ષણનું કેન્દ્ર બન્યા છો? હા ? ના

૫. તમે કોઈની સાથે સહેલાઈથી મિત્રતા બાંધી શકો છો? હા ? ના

૬. લોકોનું જૂથ ભેગું મળીને જે ઓરડામાં ચર્ચા કરતું હોય ત્યાં જતાં તમે અચકાઓ છો? હા ? ના

૭. સત્કાર-સમારંભ કે ચા-પાર્ટી વખતે ત્યાં હાજર રહેલી મહત્ત્વની વ્યકિતને મળવા પ્રયત્ન કરો છો? હા ? ના

૮. સાંસ્કૃતિક કાર્યક્રમોમાં તમે કોઈ વાર ભાગ લીધો છે? હા ? ના

૯. જાહેરમાં બોલતાં તમે મુશ્કેલી અનુભવો છો? હા ? ના

૧૦. જાહેર મેળાવડા સમક્ષ રજૂ થવાના અનુભવો તમને થયા છે? હા ? ના

૧૧. તમારી વિરુદ્ધ જાતિના સભ્યો સાથે તમે સહેલાઈથી મૈત્રીભર્યા સંબંધ બાંધી શકો છો? હા ? ના

૧૨. કોઈ વ્યકિત સાથે કોઈએ તમને તાજી જ ઓળખાણ કરાવી હોય તો તેવી વ્યકિત સાથે વાત કરતાં તમને મુશ્કેલી પડે છે ? હા ? ના

૧૩. મહોલ્લા કે શાળાના છોકરા/ છોકરીઓ સાથે કોઈ સ્થળે પર્યટનમાં ગયા હો ત્યારે અંદરોઅંદર રમત રમવામાં તમને મૂંઝવણ થાય ખરી ? હા ? ના

૧૪. બીજા લોકો માટે આયોજન કરવાનો અથવા તેને દોરવાનો તમને અનુભવ છે ? હા ? ના

૧૫. વર્ગ સમક્ષ કોઈ પણ જાતનો મૌખિક અહેવાલ રજૂ કરતી વખતે તમે મુશ્કેલી અનુભવો છો? હા ? ના

૧૬. કોઈ જાહેર સમારંભમાં સૌ સભ્યો પોતાના સ્થાને બેસી ગયા હોય ત્યારે સમારંભમાં દાખલ થતાં તમે સંકોચ અનુભવો છો ? હા ? ના

૧૭. નીરસ સમારંભ અથવા પાર્ટીને ઉત્સાહી બનાવવા માટેની પહેલ તમે કદી કરી છે? હા ? ના

૧૮. સમૂહચર્ચા વખતે કોઈ પણ જાતનો યોગ્ય અભિપ્રાય વ્યકત કરતાં તમે મુશ્કેલી અનુભવો છો? હા ? ના

૧૯; પાર્ટી અથવા સમારંભમાં ઓળખવિધિ કરવાની જવાબદારી તમે લો છો ? હા ? ના

૨૦. લોકો સાથે તમે સામાજિક મેળાવડાનો આનંદ માણી શકો છો ? હા ? ના

૨૧. જ્યારે તમે ગાડી અથવા બસમાં મુસાફરી કરતા હો ત્યારે તમારી સાથે મુસાફરી કરતી વ્યકિતઓ સાથે ચર્ચા કરવામાં પ્રવૃત્ત થાઓ છો? હા ? ના

૨૨. ઘણી વાર વર્ગમાં તમને કોઈ પ્રશ્નનો ઉત્તર આવડતો હોય અને તેના ઉત્તર માટે તમને કહેવામાં આવે ત્યારે વર્ગ સમક્ષ બોલવાના ગભરાટને લીધે નિષ્ફળ જાઓ છો ? હા ? ના

૨૩. શિક્ષક જો તમને અણધાર્યા બોલાવે તો ગભરાઈ જાઓ છો ? હા ? ના

૨૪. વર્ગમાં કોઈ વસ્તુની મૌખિક રજૂઆત કરવાની હોય ત્યારે સભાનતા ગુમાવો છો ? હા ? ના

૨૫. વર્ગમાં વાંચવાની પહેલ કરતાં તમે ખચકાઓ છો? હા ? ના

૨૬. તમારી જમવાની જુદી રીતભાતને લીધે તમે સમૂહ ભોજનમાં જતાં સંકોચ અનુભવો છો ? હા ? ના

૨૭. મ્યુનિસિપાલિટીના દીવાઓ કે જાહેર સંસ્થાઓના કાચ તોડવા જેવા પ્રસંગોમાં તમે તમારા મિત્રો કરતાં વધુ હિંમતવાળા છો એમ તમારા મિત્રો કબૂલ કરે છે ? હા ? ના

૨૮. નાટકમાં સામાજિક ટીકાના ભયે ભાગ લેવા માટે તૈયારી કરી ન હોય અને છતાંય તમને બોલવાનું કહેવામાં આવે તો તમને મૂંઝવણ થાય? હા ? ના

૨૯. તમારી વયના વિરદ્ધ જાતિના હા ? ના
મિત્રો સાથે વાત કરતા હો
ત્યારે કોઈ જોશે એવી ભીતિ
તમને થયા કરે છે?

૩૦. સમૂહમાં બોલતાં રખેને તમે હા ? ના
ખોટું બોલશો એવી મૂંઝવણ
તમને થાય છે ?

૩૧. પર્યટન જેવા પ્રસંગોમાં હા ? ના
તમારો નાસ્તો સાદો હોય
તો તે બીજા મિત્રોને આપતાં
તમને સંકોચ થાય છે ?

૩૨. તમારી મૂંઝવણો તમે તમારા હા ? ના
મિત્રોની પાસે સહેલાઈથી
રજૂ કરી શકો છો ?

૩૩. તમારી વિરુદ્ધ જાતિના મિત્ર હા ? ના
સાથે જાહેરમાં સહેલાઈથી
જઈ શકો છો ?

૩૪. તમારા બે મિત્રો વચ્ચે હા ? ના
અંદર-અંદર ઝઘડો થયો હોય
ત્યારે તમે તે ઝઘડો જોઈ ન
રહેતાં તેમની વચ્ચે સમાધાન
કરી શકો છો ?

૩૫. તમારા મિત્રની બહેનના હા ? ના
લગ્ન પ્રસંગે તમને જમવા માટે
આમંત્રણ આપેલું હોય ત્યારે
તમે પીરસવા અથવા અન્ય
કાર્યમાં લાગી જાઓ છો ?

૩૬. તમારા મહોલ્લાના છોકરા હા ? ના
તમને પોતાની સાથે ફરવા
કે અભ્યાસ કરવા માટે
બોલાવે છે ?

૩૭. સામાન્ય રીતે તમારા મિત્ર હા ? ના
સાથે તમારે વારંવાર ઝઘડા
થાય છે ?

૩૮. તમને હંમેશાં એવી લાગણી હા ? ના
થાય છે કે તમારા વિષેની
કોઈ ખાનગી વાતો કરે છે ?

૩૯. તમારા મિત્રો સાથેની ચર્ચા હા ? ના
કરવામાં હારી જાઓ તે બીકે
કોઈ વખત આવી દલીલોમાં
ભાગ નહીં લેવાનું નક્કી
કરો છો ?

૪૦. કોઈ પણ પ્રકારની તમને હા ? ના
તમારી ન્યૂનતા લાગ્યા કરતી
હોય અને તે કારણે તમને
સમૂહમાં આગળ પડતો ભાગ
ન લેવામાં મૂંઝવણ થયા
કરે છે ?

નામ : ____________ **વય:** ________ **તારીખ:** ________

સંસ્થા : ____________ **વર્ગ :** ________ **જાતિ (છોકરો/છોકરી) :** ________

INTELLIGENCE : DESCRIPTIVE CONCEPTIONS OF ITS NATURE

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Accompanying the advance of scientific knowledge of intelligence, there has developed an extensive folklore about the whole matter. Perhaps no term in Psychology other than intelligence is so generally used with functional meaning by young and old, literates as well as illiterates and yet, it is the very term which is found difficult to define with exactness by Psychologists. Physical scientists, too, are at stake while defining some physical terms. As for example, 'electricity' can be experienced and measured by its varied effects but is defined in a round about manner. The same holds true for the term 'intelligence'. It can be known and measured by observing how one behaves in a standardised situation as that of testing, but, no two definitions reveal one and the same thing.

An attempt is made here to give a brief survey of the various descriptions of intelligence beginning from Cicero and ending with the modern period of Piaget and Hebb.

Origin of the Concept :

According to Cyril Burt (2) the term intelligence goes back to intelligentia, a term introduced by Cicero. The former, then, adds :

> "As Guilford has reminded us, the modern notion of 'intelligence as a unitary entity' was a gift to psychology from biology through the instrumentality of Herbert Spencer. .. .. .. During the evolution of animal kingdom, and during the growth of the individual child, the fundamental capacity of cognition progressively differentiates into a hierarchy of more specialized abilities —sensory, perceptual, associative and relational, much as the trunk of a tree sprouts into boughs, branches and twigs. To designate the basic characteristic, Spencer revives the term **'intelligence'.**

Definitions of Intelligence :

After the first scale of intelligence measurement was published by Binet and Simon, psychologists tried to study and define the term intelligence critically. Symposia were held on the problem, and numerous voices were heard. According to Spearman, as quoted by Guilford (4), intelligence became a ' mere vocal sound, a word with so many meanings that finally it had none '. To present a mere parade of definitions would serve no purpose but would rather be a dull affair. Commenting on the definitions of intelligence, McNemar (7) humorously stated, " It might be claimed that no definition is required because all intelligent people know what intelligence is — it is the thing that the other guy lacks ".

After studying many a definition of intelligence, Mursell (9) concludes that the prevailing impression is not one of contradiction but of vagueness. It is true there are differences in emphasis, but on the whole it could not seem very difficult to reconcile these various formulations. Pintner (11) classified different definitions into four broad categories, namely, (*i*) biological (*ii*) educational, (*iii*) facutly, and (*iv*) empirical and discussed them with illustrations, while F. N. Freeman classified them as (*i*) organic. (*ii*) social, and (*iii*) behavioristic. As the various groupings overlap, it would be difficult to assign any given definition to some particular grouping. Mursell (9) rightly concludes :

> What Pintner and Freeman have actually succeeded in doing is to play up the indubitable truth that general intelligence is a vague concept and that it may probably be considered from many different though by no means of conflicting view points.

Commenting on the definitions given by various psychologists in reply to the questions of the Editor of The British Journal of Educational Psychology, A. W. Heim (6) writes that very roughly these psychologists can be divided into four groups : (*a*) those that dealt with adjustment or adaptability, (*b*) those that laid the main stress on learning, (*c*) those that described it in the form of enumerated qualities; and (*d*) those few cautious contributors who declined to commit themselves. F. S. Freeman (3) classifies the existing definitions into the following three categories of abilities designated by them : (*i*) ability to adapt or adjust to one's environment, (*ii*) ability to learn; and (*iii*) ability to carry on abstract thinking and then he states emphatically that these three categories of definitions are not and cannot be mutually exclusive.

As far as the first two categories are concerned, Heim and Freeman both convey one and the same thing. If abstract thinking is considered as one of the qualities enumerated, there would not be any difference between the third category of both, except that one of Heim is rather a broad one. The fourth category given by Heim can safely be omitted from the list as it does not convey any new ability of its own; or, to put it in other way, a fourth category, namely, ability that does not fall in with any of the first three categories properly, can be added to Freeman's list, if so permitted, for the writer feels that this addition would connote the same thing what the fourth grouping of Heim does. Again, there would be no problem, then, to categorise any definition whatsoever.

These different attempts, just mentioned, to categorise and combine the divergent views bring out the fact that intelligence is highly complex and that tests of intelligence should be very mixed. They also lead to comprehensive definitions of intelligence which would now be dealt with.

Descriptions of Intelligence :

As Mursell (9) remarks, the attempt to compress the concept of intelligence into a compact definition is too complex, too many-sided, too wide-ranging, and too vague. Accordingly, there have been various attempts to describe it in a more comprehensive manner rather than define it in a compact form. The noteworthy attempts to define intelligence comprehensively are those of Stoddard, Wechsler, Piaget, Thorndike and Hebb; the last two, of course, describe types of intelligence.

Stoddard (13) describes intelligence, treating it as a theoretical composite whose elements may be operationally tested :

> Intelligence is the ability to undertake activities that are characterized by (1) difficulty, (2) complexity, (3) abstractness, (4) economy, (5) adaptiveness to a goal, (6) social value, and (7) the emergence of originals, and to maintain such activities under conditions that demand a concentration of energy and a resistance to emotional forces.

He, then, brings out the features of each of the attributes at great length. Difficulty which is a function of the 'percentage passing' as well as a function of population must increase with chronological age, so long as mental growth is postulated. Stoddard (13) remarks that it must be, to be meaningful, truly hierarchical and not simply a broadening of the base. Complexity, he clarifies, refers to the breadth or area of intelligence. In other words, the term complexity refers to the number of tasks that can be successfully undertaken by the individual. Mursell (9) writes that complexity is not a mere matter of additive range. It refers to the ability to hold together many considerations in a unitary effort, such as manifests itself in any high level skill, or in complex research. Stoddard (13) adds that complexity cannot be just a profile nor a graph expressing area and altitude in two dimensions. It is rather area-altitude as a dimension of structure (complexity – difficulty) that rises to levels of greater insight. For him, the third attribute of abstractness " lies at the heart of intelligence as defined ". It is the key characteristic of all highl evel mental operations. Coming to the fourth attribute of intelligence, he remarks that ' economy ' is another name for speed — the accomplishment of the most mental tasks in the least time. However, he prefers the word *economy* to *speed* for the latter implies fast motion without sufficient stress upon direction and accuracy.

While discussing the fifth and the sixth attributes, Stoddard (13) states that they — adaptiveness to a goal and social value — tend to merge. Regardless of the test content revealing these attributes, the first reference point is to individual behaviour and the second to the more slowly changing mores. Freeman (3) questions whether existing intelligence tests do, or even could, satisfactorily test this fifth attribute. For the sixth attribute, he comments :

> The inclusion of ' social value ' as an attribute of intelligence is of doubtful validity, and debatable at best; for this criterion is essentially moral or ethical, or a matter of subjective evaluation.

The seventh one, the emergence of originals, is included, as Stoddard puts, as an attribute because of its special place at the upper end of any valid distribution of intelligence. Sherman (12) opines that predictions regarding the productivity of an individual with a high I. Q. are difficult to make, especially because no systematic study has been reported in which a significant number of children classified as geniuses have been studied through their adult years.

Citing two further conditions identifying intelligent behaviour, Stoddard (13) himself confesses that this condition of concentration, considered in both immediate and long-range application, is poorly provided for in standard mental testing. Emotional blockings, the second condition, may operate in a direct physiological fashion. As he comments, high anger and high thinking are mutually inconsistent as simultaneous processes. These two conditions, "concentration of energy" and "resistance to emotional forces", being regarded as non-intellectual aspects of activity, cannot be directly measured; true it is; but they cannot be overlooked. The cautious examiner does, in fact, try to develop or encourage conditions wherein the examinee will be motivated fully to put forth his best efforts by concentrating his energy on the tests and resisting the emotional forces. This is, rather, a must for a clinical examination. It is, here, that an individual test of the Stanford-Binet type, is needed the most.

Wechsler's Description :

Wechsler (16) defines intelligence as the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment. The definition specially states that an individual's intelligence is revealed by his behaviour as a whole, and that intelligence involves behaviour toward a goal which may be more or less immediate. The inclusion of phrases 'to act purposefully' and 'to deal effectively' specify that 'drive' or 'incentive' enter into intelligent behaviour. Wechsler (16) clearly emphasizes these aspects by supporting Alexander's findings, which include a reference to such non-intellective aspects. It can be seen that though Wechsler acknowledges 'drive', 'incentive', 'temperament' as basic factors in general intelligence and holds that general intelligence cannot be equated with intellectual ability, but must be regarded as a manifestation of the personality as a whole, he has not been able to redevise his two world-wide famous scales — Wechsler Adult Intelligence Scale (WAIS) and Wechsler Intelligence Scale for Children (WISC) — to include the measurement of the non-intellectual traits. Wechsler, however, seems to have been quite conscious of this. In the preface to the 1958 edition (16) of his works, he writes :

> I look upon intelligence .... as a resultant of interacting abilities — non-intellectives included. The problem confronting psychologists to-day is how these abilities interact to give the resultant effect we call intelligence. At this writing it seems clear that factorial analysis alone is not the answer. Probably a new statistic involving field-theory and non-linear differential equations will be required. Inthe meantime, I remain a reformed but unchastened Spearmanite.

Piaget's Conceptions of Intelligence :

With respect to his general views on intelligence, Jean Piaget distinguishes three aspects : content, function and structure. 'Content', here, means observable aspects of behaviour, the source of information which the psychologist utilises to start with. 'Function' pertains to broad principles of intellectual activity, principles which remain invariant with age and with experience in contrast with the 'structure' which is essentially equivalent to knowledge, do change.

The organism always acts in terms of the centrally organised, gestalt-like structures which are observed as repeatable and generalizable pieces of behaviour. These structures are termed as "Schemata" by Piaget. The schemata function in two important ways which are 'assimilation' and 'accommodation'— both biological terms utilised by the biologist Piaget ! In the psychological domain, assimilation is a matter of taking input from sensory inlets and incorporating new elements into the existing structure of knowledge. Accommodation, the process complementary to assimilation, means self-adjustment on the part of the organism, modifying an already existing structure to make it better adapted to the new additions.

Again, Piaget talks about the 'concrete' operations in intellectual development which begins at about 2 years age of the child and lasts till he is 11 or 12, and the formal operations starting at about 11 or 12 years and continuing till long.

It would, now, be easy to grasp the description of intelligence given by Piaget (10) as :

> Intelligence constitutes the state of equilibrium towards which tend all the successive adaptations of a sensorimotor and cognitive nature, as well as all assimilatory and accommodatory interactions between the organism and the environment.

Three Kinds of Intelligence :

Under the effect of this era of specifications E. L. Thorndike specified intelligent activity into three types : (1) social intelligence or ability to understand and deal with persons; (2) concrete intelligence or ability to understand and deal with things; (3) abstract intelligence or ability to understand and deal with verbal and mathematical symbols.

This division indicates the need for designing separate tests to measure how effectively the individual is functioning in each. But psychologists discordant with Thorndike's views do not think that such specialized measurement is necessary. Freeman (3), here, remarks that though in the case of any given person the score attained on a test of abstract intelligence might differ appreciably from those obtained by him on a test of 'social' relationships and insights, or on one of 'concrete' intelligence, the correlations between the types of tests are found to be positive and significant, both psychologically and statistically, when "a representative group" of individuals are tested.

It is an indubitable fact that tests of abstract intelligence outweigh others and are most pronounced in current tests of intelligence which are designed for use with persons, who are presumed to have developed facility in dealing with concepts and symbols, on the grounds of maturity. The testing of concrete intelligence is usually restricted to the earliest developmental levels but it has only slight predictive value for later development of mental abilities. As Freeman (3) observes, even tests that present the subject with 'things' rather than with ideas and symbols are not devoid of demands upon ability to conceptualize and make abstractions, although the subject need not necessarily respond in the form of language and number.

The Two Meanings of Intelligence :

Vernon (14) has rightly concluded that now all earlier work on the nature of intelligence has been put in the shade by Piaget's recent books and by Hebb's "The Organisation of Behaviour".

The clinical evidence put forth by Hebb (5) indicates that there are two components in intelligence-test performance and in any intelligent behaviour. One is diminished immediately by damage to the brain, and amounts to a factor of heredity; the other is related more to experience, consisting of permanent changes in the organisation of pathways in the cerebrum.

As Hebb (5) states :

> One is (A) an *innate potential*, the capacity for development, fully innate property that amounts to the possession of a good brain and a good neural metabolism. The second is (B) the functioning of a brain in which the development has gone on, determining *an average level of performance or comprehension* by the partly grown or mature person.

Intelligence B is that one that is inferred from observing the individual's behaviour in the presence of a variety of intelligence test-items. It does not develop fully in the absence of suitable environmental stimulation. Intelligence A is a more difficult thing to come to grips with, and is presumably dependent on the genes. Vernon (14), here, remarks that " Intelligence A is the innate capacity for acquiring what we ordinarily mean by intelligence." It is, of course, purely hypothetical; we can never directly observe its operation, nor measure it." Vernon (15), afterwards, suggested adding intelligence C to Hebb's dichotomy because " far too many people who ought to know better — psychologists and sociologists as well as teachers and laymen are apt to refer to test results as *intelligence*". Thus, according to him, ' Intelligence C ' means Mental Age or I. Q. or score on one of the widely used intelligence tests.

Hebb's two meanings of intelligence and discussion thereupon, pour cold water on the old and often noisy debate on the issue of nature versus nurture in intelligence. Anastasi (1), too, in " Heredity, Environment and the Question ' How ' ? " holds :

> It is now generally conceded that both hereditary and environmental factors enter into all behaviour. The reacting organism is a product of its genes and its past environment, while present environment provides the immediate stimulus for current behaviour.

The Present Position :

On re-examining the problem of defining intelligence, Miles (8) found himself struggling with the awful fact that the word ' definition ' itself has six "different senses" and he comments that " it seems to me that the issue has often been confused by *unnecessary* disputation and by argument at cross-purposes ".

Quinn McNemar (7), in his recent article " Lost : Our Intelligence ? Why ?" has indicated some solution and it is :

> Perhaps the resolution of this problem should be assigned to the newly formed Division of Philosophical Psychology, or may be the problem should be forgotten since psychologists seem to have lost the concept of general intelligence.

Whether one likes this clue or not; whether this clue is correct or incorrect; it seems that defining intelligence is not the job of the practical psychologists who design new tests or of ones who adapt some tests. They can, however, go on with their work without bothering about the definition of intelligence.

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EFFECT OF ORGANIC SUBSTANCES ON COAGULATION VALUES OF ZIRCONIUM OXIDE SOLS

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Abstract

Effect of organic substances on the coagulation values of zirconium oxide sols have been studied. It has been observed that alcohols sensitize the sol while glucose and sucrose stabilize the sol.

* * *

The effect of organic substances on the coagulation of colloids by different electrolytes has been observed by a number of workers Kruyt and van Duin[1] pointed out that the coagulation values of arsenic trisulphide sol with different electrolytes were affected by the presence of capillary active substances like amyl alcohol and phenol. Mukherjee et. al.[2] and Chatterji and Ram Nath[3] studied the effect of organic substances on the coagulation values of arsenic trisulphide sol. Chaudhary and Chatterji[4] studied the effect of organic substances on the coagulation value of copper ferrocyanide sol Weiser[5] studied the effect of organic substances on the coagulation value of iron oxide sol. Chaudhary and Ganguly[6] also studied the effect of organic substances like pyridine, urea, etc., on the coagulation values of iron oxide sol. In the case of aluminium oxide sol and stannic oxide sol, changes in flocculation values when sols were diluted with alcohol instead of water were studied by Fisher and Sorum[7].

During present investigation, dialysed zirconium oxide sol was employed. Coagulation values were determined as described earlier.[8] In a series of test tubes previously cleaned and dried, 20. ml. of the sol was taken in each of the test tubes. This was called series 'A'. In the second series of test tubes called 'B', the suitable mixture of organic substance and the coagulating electrolyte was taken and the test tubes were kept in the water bath (temp. 30±1°) for thirty minutes to attain the bath temperature. The solution in series 'B' were added to the sol in test tubes in series 'A'. The test tubes were treated as in ordinary coagulation value experiments. The first test tube with clear supernatent liquid (after an hour of the time of mixing) was taken to give the coagulation value. The results obtained are given in Tables I and II.

TABLE I

Concentration of the original sol 5·0 g./1.
Purity of the sol = 7

Percentage by volume of Organic substance		*Coagulation value of electrolyte in percentage*		
		KCl	K_2SO_4	$K_3Fe(CN)_6$
Methyl alcohol	–	100·0	100·0	100·0
	20·0	83·3	105·8	96·4
	40·0	53·0	100·0	90·4
Ethyl alcohol	–	100·0	100·0	100·0
	20·0	56·6	100·0	96·4
	40·0	33·3	94·1	90·9
Propyl alcohol	–	100·0	100·0	100·0
	20·0	66·6	100·0	87·2
	40·0	40·0	94·1	90·9
Acetone	–	100·0	100·0	100·0
	20·0	60·0	94·1	96·4
	40·0	26·6	88·2	87·4
Glucose (10% soln.)	–	100·0	100·0	100·0
	20·0	250·0	111·7	100·0
	40·0	308·3	111·7	96·2
Sucrose (10% soln.)	–	100·0	100·0	100·0
	20·0	166·6	111·7	100·0
	40·0	174·9	105·8	100·0
Urea 1M	–	100·0	100·0	100·0
	20·0	120·0	105·8	100·0
	40·0	116·6	105·8	100·0

Thiourea 1M	–	100·0	100·0	100·0
	20·0	110·0	100·0	100·0
	40·0	103·3	100·0	96·4

TABLE II

Concentration of the original sol : 4·8 g./1.
Purity of the sol = 16

Per cent by volume of organic substance		*Coagulation values of electrolytes in percentage* KCl	K_2SO_4	$K_3Fe(CN)_6$
Methyl alcohol	–	100·0	100·0	100·0
	20·0	72·4	95·0	100·0
	40·0	48·3	95·0	95·8
Ethyl alcohol	–	100·0	100·0	100·0
	20·0	55·2	90·0	100·0
	40·0	27·6	90·0	91·7
Propyl alcohol	–	100·0	100·0	100·0
	20·0	51·7	90·0	91·7
	40·0	27·6	95·0	95·8
Acetone	–	100·0	100·0	100·0
	20·0	55·1	85·0	95·8
	40·0	24·1	95·0	87·5
Glucose (10% soln.)	–	100·0	100·0	100·0
	20·0	361·7	105·0	100·0
	40·0	482·6	115·0	95·8
Sucrose (10% soln.)	–	100·0	100·0	100·0
	20·0	172·4	95·0	100·0
	40·0	206·9	100·0	95·8
Urea 1M	–	100·0	100·0	100·0
	20·0	96·5	100·0	100·0
	40·0	96·5	95·0	91·7
Thiourea 1M	–	100·0	100·0	100·0
	20·0	93·1	95·0	95·8
	40·0	93·1	95·0	95·8

TABLE III

$a = 20\%$ organic substance | $b = 40\%$ organic substance

Sol	*Valency*	*Marked Sensitization*	*Sensitization*	*No effect*	*Antagonism*	*Marked antagonism*
A	Monovalent KCl	Acetone (*b*)	Methyl alcohol (*a–b*) Ethyl alcohol (*a–b*) Propyl alcohol (*a–b*) Acetone (*a*)	Thiourea (*b*)	Sucrose (*a*) Urea (*a–b*) Thiourea (*a*)	Glucose (*a–b*) Sucrose (*b*)
B	”	Ethyl alcohol (*b*) Propyl alcohol (*b*) Acetone (*b*)	Methyl alcohol (*a–b*) Ethyl alcohol (*a*) Propyl alcohol (*a*) Acetone (*a*)	Urea (*a–b*) Thiourea (*a–b*)		Glucose (*a–b*) Sucrose (*a–b*)
A	Bivalent K_2SO_4		Acetone (*b*)	Methyl alcohol (*a–b*) Ethyl alcohol (*a–b*) Propyl alcohol (*a–b*) Acetone (*a*) Sucrose (*b*) Urea (*a–b*) Thiourea (*a–b*)	Glucose (*a–b*) Sucrose (*a*)	
B	”		Acetone (*a*)	Methyl alcohol (*a–b*) Ethyl alcohol (*a–b*)	Glucose (*b*)	

			Propyl alcohol (*a–b*) Acetone (*b*) Glucose (*a*) Sucrose (*a–b*) Urea (*a–b*) Thiourea (*a–b*)
A	Trivalent $K_3Fe(CN)_6$	Propyl alcohol (*a*) Acetone (*b*)	Methyl alcohol (*a–b*) Ethyl alcohol (*a–b*) Propyl alcohol (*b*) Acetone (*a*) Glucose (*a–b*) Sucrose (*a–b*) Urea (*a–b*) Thiourea (*a–b*)
B	,,	Acetone (*b*)	Methyl alcohol (*a–b*) Ethyl alcohol (*a–b*) Propyl alcohol (*a–b*) Acetone (*a*) Glucose (*a–b*) Sucrose (*a–b*) Urea (*a–b*) Thiourea (*a–b*)

It may be convenient to define the order of sensitization etc., as follows :

(*a*) The reduction of coagulation values to 30% and less is referred to as "marked sensitization".

(*b*) The reduction of coagulation values to 30% to 90% is "sensitization".

(*c*) The change in coagulation values from 90% to 110% is considered "no effect".

(*d*) The change in coagulation values from 110% to 170% is referred to as "antagonism".

(*e*) The change in coagulation value above 170% is termed as "marked antagonism".

The data obtained may be summarized as follows :

In the case of monovalent ions, (*a*) marked sensitization is observed in the case ethyl alcohol, propyl alcohol and acetone when organic substences are present to the extent of 40% (maximum tried in the present investigation). (*b*) Sensitization is observed in the case of methyl alcohol in all proportions tried and ethyl alcohol, propyl alcohol and acetone when present to the extent of 20%. (*c*) marked antagonism is observed in the case of glucose (10%) and sucrose (10%). (*d*) the sensitizing effect of alcohols and acetone as well as the stabilizing effect of glucose and sucrose increases with purity.

In the case of bivalent and trivalent ions, organic substances tried have no effect.

The results obtained are in general agreement with those of other workers. Fisher and Sorum[9] report that when stannic oxide sol of different dilutions was coagulated with monovalent ion, the coagulation value increases when the sol is diluted with water and decreases when diluted with alcohol. Kvyat[10] studied the effect of serveral organic substances on the coagulation values of the electrolytes in the case of iron and aluminium oxide sols and concluded that the sols are sensitized towards sodium chloride, the sensitization effect being of the order of tannin > gallic acid > pyregallol > hydroquinone > resorcinol > phenol > mannitol > glucose. His conclusion was that the glucose has very little effect on the coagulation value.

Weiser[11] studied the coagulation values of iron oxide sol by potassium chloride, potassium oxalate and potassium sulphate in the presence of phenol and iso-amyl alcohol. He concluded that there is sensitization when coagulated by monovalent ion; while in the case of bivalent ion there is very little sensitization, i.e., the coagulation value of bivalent electrolyte remains unchanged.

In the case of arsenic trisulphide sol, Mukherjee, Chaudhary and Mukherjee[12] report, " In the case of potassium and lithium chloride for the five of the added substances the colloid appears to be sensitized excepting the case of ethyl alcohol which stabilized the sol against coagulation by these electrolytes ". The stabilized effect of ethyl alcohol is surprising in the case of arsenic trisulphide sol, in view of the fact that in case of methyl alcohol, they report sensitization. Again in the case of chromium oxide sol[13], aluminium oxide sol[14], stannic oxide sol[15], silica sol[16] and zirconium oxide sol, there is sensitization in the presence of ethyl alcohol.

Various attempts have been made to explain the effect of organic substances on the coagulation value. According to Freundlich[17], " The non-electrolytes are adsorbed by the colloid particles. It has indeed not been possible to prove this directly, probably because with dilute Fe_2O_3 sols used, the quantity of the adsorbant was too small; since the content of the non-electrolyte in the solution was determined after coagulation, it is also possible that a reversal of the adsorption itself was obscured. If we assume an adsorption at the interface, the dielectric constant, there will be distinctly lowered since all the non-electrolytes have decidedly lower dielectric constant than that of water (5 to 20 against 81)". Freundlich is of the view that the effect of organic substance is to depress the charge of the micelles. This view is further developed by Weiser.[18]

(1) " The adsorption of a non-electrolyte by the particles of the precipitating ions must be adsorbed in order to decrease the charge below the critical values necessary for agglomeration and precipitation. The extent of sensitization depends on the concentration and adsorbability of the non-electrolyte and its dielectric constant. This effect tends to lower the precipitation value of an electrolyte. The amount of lowering is the greatest for the electrolytes with weakly adsorbed precipitating ions that precipitate only in relatively high concentration.

(2) The adsorption of a non-electrolyte by the particles of a sol cuts down the adsorption of the precipitating ion of the electrolyte added to produce the coagulation. This effect tends to raise the precipitation value of an electrolyte.

(3) Since the factors mentioned above have opposite effects on the precipitation value of the electrolytes, it follows that depending on the condition, the precipitation value may be increased, decreased or remain unchanged, in the presence of a non-electrolyte ".

The dielectric constant of the organic substance and its adsorption on the surface of the colloidal particle are important factors. Thus Chatterji and Ram Nath emphasized the importance of the lowering in the dielectric constant and the lowering of the solid-liquid interfacial tension. The addition of a non-electrolyte with a lower dielectric constant lowers the dielectric constant of the medium. This may affect the stability in three ways :

"It brings about (*i*) a greater repulsive force between the colloidal particles on account of which the sol becomes stabilized (*ii*) an increased electrical adsorption of the oppositely charged ions by the colloid which will sensitize the sol and (*iii*) a repulsion between the similarly charged ions, which means that they are less adsorbed and hence sensitization results. The net effect will depend upon the magnitude of these three factors ".

An important factor for sensitization with alcohol appears to be dehydrating effect of alcohol on the micelles. Overbeak and Bungenberg de Jong[19] studied the viscosity of many colloids when diluted with water and alcohol and concluded that the decrease in $n_s - n_o / n_o$ from the view point of Einstein's equation must be interpreted as a process of desolvation. The dehydration effect of alcohols is also realised by Fisher and Sorum[7] who studied the applicability of Burton–Bishop rule to chromium oxide sol, aluminium oxide sol and stannic oxide sol. They found that only highly purified sols in which the micelles are very greatly hydrated obey Burton–Bishop rule. When, however, a highly purified sol which obeys Burton–Bishop rule was diluted with alcohol instead of water, the rule was not obeyed. This is obviously due to the dehydrating action of the organic substances such as alcohols.

In the case of zirconium oxide sol, two factors appear to be important in governing the effect of alcohol on coagulation values (*a*) the change in dielectric constant of the medium, and (*b*) the dehydration action of alcohols. Another factor which appears to be operative in the case of glucose and sucrose may be their preferential adsorption leading to stabilization. It will be better if broad generalization only are formed. One may conclude with Chaudhary and Chatterji[4], " It is obvious that several factors are at work and it is a priori difficult to predict what is going to happen in a particular case. The specificity of the stabilizing or sensitizing effect is to be attributed to the fact that we observe the net result of changes in the large number of variables which affect the coagulating concentration ".

Thanks are due to Professor A. M. Trivedi for interest in the work and the Ahmedabad Education Society for the laboratory facilities.

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NITROGEN MUSTARD-THIOUREAS

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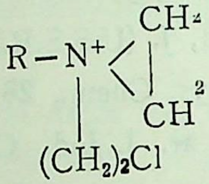
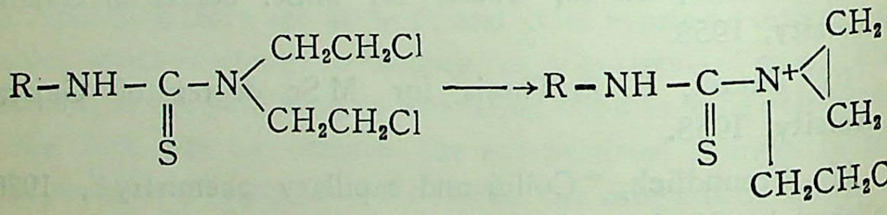
A Japanese patent[1] describes preparation of several *N* (bis-β-chloroethyl)-aminoglycine amides as anticancer compounds. Famous nitrogen mustards used against neoplastic diseases and as antitumor drug also contain bis (β-chloroethyl) amino group responsible for the activity. The nitrogen mustards owe their antitumor activity due to their ability to cyclise to highly reactive ethylenimonium ions in polar solvents[2].



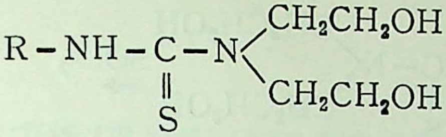
Thioureas are also found to show considerable activities as tuberculotatics[3]. Incorporating a thiourea moeity with nitrogen mustard moeity may enhance one of the above activities since the formation of reactive ethylenimonium ions considered to be responsible for antitumor activity is not hindered.



These compounds can also be regarded as ethylenimonium ions containing thioamido group. Thioamides also show fungistatic and bacteriostatic properties[4].

Several compounds containing these moeities and named as N'-(bis-β-chloroethyl)-N^3-sub. phenylthioureas are prepared to evaluate their pharmacological properties and are discussed in the present paper.

TABLE I

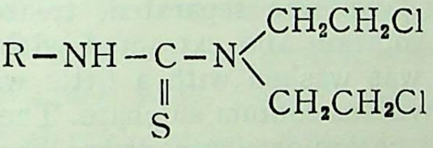


$$R-NH-\underset{\underset{S}{\parallel}}{C}-N\begin{cases}CH_2CH_2OH\\CH_2CH_2OH\end{cases}$$

N′ (bis – β – hydroxyethyl) – N³ – phenyl – thioureas.

No.	*R*	*m.p.* °*C*	*Molecular formula*	*Analysis % of S* *Found*	*Calc.*
1.	C_6H_5-	128	$C_{11}H_{16}N_2O_2S$	13·0	13·3
2.	$p-Br-C_6H_4-$	129	$C_{11}H_{15}BrN_2O_2S$	9·8	10·0
3.	$o-Cl-C_6H_4-$	239(d)	$C_{11}H_{15}ClN_2O_2S$	11·5	11·65
4.	$m-Cl-C_6H_4-$	189	$C_{11}H_{15}ClN_2O_2S$	11·6	11·65
5.	$p-Cl-C_6H_4-$	92	$C_{11}H_{15}ClN_2O_2S$	11·6	11·65
6.	$o-CH_3-C_6H_4-$	95	$C_{12}H_{18}N_2O_2S$	12·4	12·6
7.	$m-CH_3-C_6H_4-$	210	$C_{12}H_{18}N_2O_2S$	12·5	12·6
8.	$p-CH_3-C_6H_4-$	137	$C_{12}H_{18}N_2O_2S$	12·5	12·6
9.	$o-CH_3O-C_6H_4-$	139	$C_{12}H_{18}N_2O_3S$	11·9	11·8
10.	$p-CH_3O-C_6H_4-$	194	$C_{12}H_{18}N_2O_3S$	11·8	11·8
11.	$C_6H_5OH_2-$	175	$C_{12}H_{18}N_2O_2S$	12·5	12·6

TABLE II

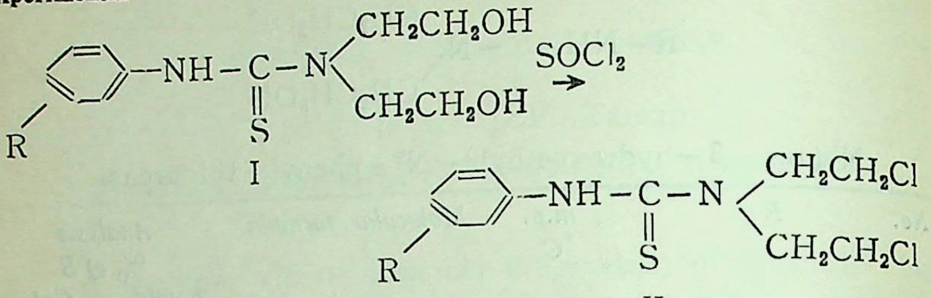


$$R-NH-\underset{\underset{S}{\parallel}}{C}-N\begin{cases}CH_2CH_2Cl\\CH_2CH_2Cl\end{cases}$$

N′ (bis – β – chloroethyl) – N³ – phenyl – thioureas.

No.	*R*	*m.p.* °*C*	*Molecular formula*	*Analysis of % S* *Found*	*Calc.*
1.	C_6H_5-	193	$C_{11}H_{14}Cl_2N_2S$	11·4	11·5
2.	$p-BrC_6H_4-$	153	$C_{11}H_{13}BrCl_2N_2S$	8·8	8·99
3.	$o-Cl-C_6H_4-$	193	$C_{11}H_{13}Cl_3N_2S$	10·2	10·3
4.	$m-Cl-C_6H_4-$	233	$C_{11}H_{13}Cl_3N_2S$	10·3	10·3
5.	$p-Cl-C_6H_4-$	148	$C_{11}H_{13}Cl_3N_2S$	10·2	10·3
6.	$o-CH_3-C_6H_4-$	138	$C_{12}H_{16}Cl_2N_2S$	10·9	11·0
7.	$m-CH_3-C_6H_4-$	257	$C_{12}H_{16}Cl_2N_2S$	10·7	11·0
8.	$p-CH_3-C_6H_4-$	198	$C_{12}H_{16}Cl_2N_2S$	10·9	11·0
9.	$o-CH_3OC_6H_4-$	154	$C_{12}H_{16}Cl_2N_2OS$	10·3	10·4
10.	$p-CH_3OC_6H_5-$	160	$C_{12}H_{16}Cl_2N_2OS$	10·4	10·4
11.	$C_6H_5CH_2-$	213	$C_{12}H_{16}Cl_2N_2S$	10·9	11·0

Experimental



I

II

Preparation of I : Isothiocyanate (0·01 mole) and diethanolamine (0·01 mole) were refluxed in 15 ml ethanol for four hours on water bath. Ethanol was recovered and the product obtained was crystallised from ethanol. Average yields were in the range 70–75%.

Preparation of II : 0·015 mole of I dissolved in a mixture of dry chloroform (10 ml) and chlorobenzene (5 ml). The solution was warmed to 50°C and thionyl chloride (0·03 mole) in chlorobenzene (5 ml) was added drop-wise with stirring during 15 min. (moisture to be excluded). It was then refluxed on a water bath for 1 hour. Ice-cold water (20 ml) was then added to the reaction mixture which was left to cool in ice.

The aqueous layer was separated, treated with a small excess of $NaOH$ solution and extracted with chloroform. The chloroform layer was washed with a little water and dried for 24 hours over anhydrous sodium sulphate. The product obtained on evaporation of chloroform was crystallised from ethanol. Average yields were in the range 40–45%.

Authors thank Mr. M. S. Solanki for supplying some of the intermediates. One of us (I.D.S.) is indebted to Gujarat University for a research grant which made this investigation possible.

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PURIFICATION OF SOLVENTS FOR ULTRAVIOLET SPECTROPHOTOMETRY

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Though a variety of organic solvents are used for a study of the light absorption characteristics of substances in the ultraviolet region of the spectrum, the commercial samples of these solvents contain traces of impurities which absorb ultraviolet light, thus decreasing their light transmission in this spectral range.

Various methods have been adopted for the purification of nonpolar solvents. Thus, a chemical process was used by Castille[1] to purify petroleum ether, while Linnel[2] used a similar process for the purification of cyclohexane. Adsorption processes using silica gels have been described by Mair[3], Graff[4], Ashmore[5], Potts[6], Vinogradov[7] and Hesse[8]. Activated charcoal has been used as an adsorbent by Pirlot[9] and Kubo[10].

However, the attention given to the purification of polar organic solvents does not seem to be adequate. Methanol was purified by Pirlot (loc. cit.), while purification for the ultraviolet spectrophotometry has been carried out by Leighton[11], Clow[12], Pirlot[9] and Gage[13]. Purification of isopropylalcohol as solvent for ultraviolet spectrophotometry has not been reported yet.

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The present study was undertaken to evaluate the various processes reported for the purification of n–hexane, cyclohexane, and ethyl alcohol, and to develop methods for the purification of n–heptane, methylcyclohexane, methanol and isopropyl alcohol for use as solvents for the ultraviolet spectrophotometry.

Experimental :

n–hexane :

Hexane was purified by the processes suggested by Castille, Mair, Graff, Pirlot and Hesse (loc. cit.). However, none of the methods adopted by them gave the desired transparency to the solvent and therefore the process was modified and developed as follows :

Commercial Hexane was stirred with a mixture of sulfuric acid and nitric acid at 0°C for four hours, to remove traces of aromatic

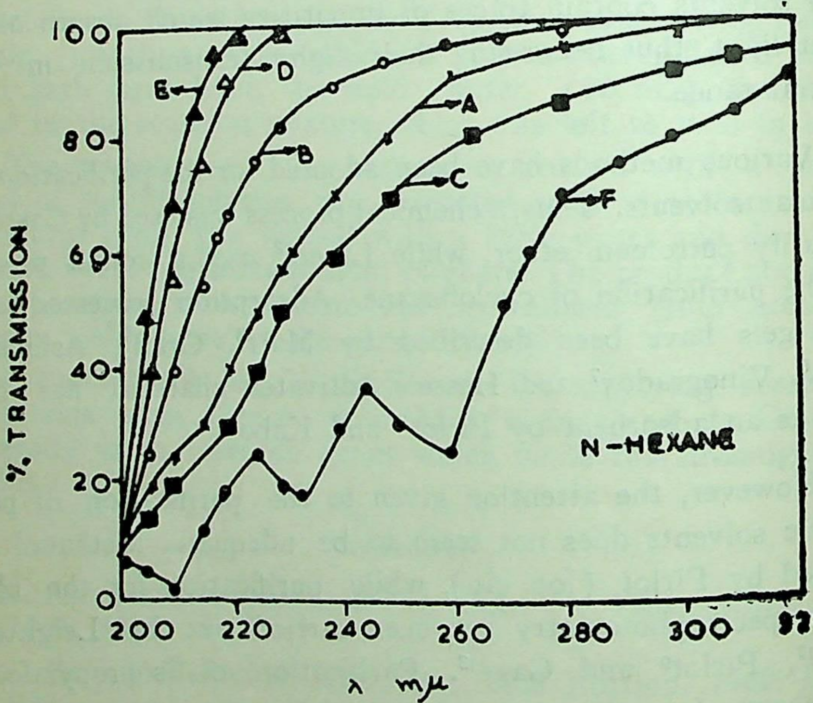

Figure 1—Transmission of ultraviolet light by n–Hexane.
A–purified by method of Castille and Henry.
B–purified by passing over silicagel.
C–purified by passing over activated charcoal.
D–purified by method of Hesse and Schildknecht.
E–purified by process of described on page 145.
F–untreated.

compounds. The hydrocarbon layer was separated, washed with distilled water and distilled subsequently. The distillate was dried over anhydrous calcium sulfate and passed through a column of silica gel (one meter long) and a column of aluminium oxide, [chromatographic reagent] 50 cm. long. The transparency of samples purified by various processes are given in Figure 1.

Cyclohexane :

At first, cyclohexane was purified by the processes reported by Pirlot, Kubo, Hesse, Linnel (loc cit.). But, as satisfactory results could not be attained, a process described below was developed.

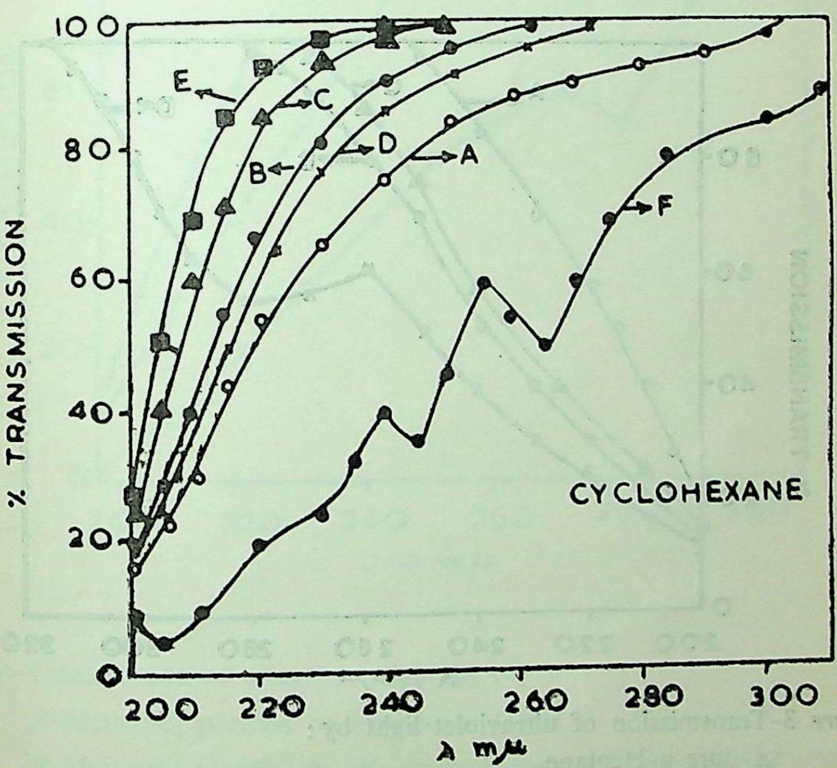

Figure 2–Transmission of ultraviolet light by Cyclohexane.
A–purified by passing over activated charcoal.
B–purified by passing over Silica gel.
C–purified by the method of Hesse and Schildknecht.
D–purified by the method of Linnel and Umar.
E–purified by process described on page 146.
F–untreated.

The specimen of cyclohexane was first purified by treatment with sulfuric acid to remove aromatic compounds. It was then washed with distilled water, dried over "drierite" and distilled. The distillate was then passed over a one meter long column of silica gel and a 50 cm. column of aluminium oxide. Figure 2 shows the ultraviolet transmission of the specimens before and after the treatment.

Ethylalcohol :

A comparison of the methods adopted by Leighton, Pirlot and Gage (loc. cit.) showed that Leighton's method was the best.

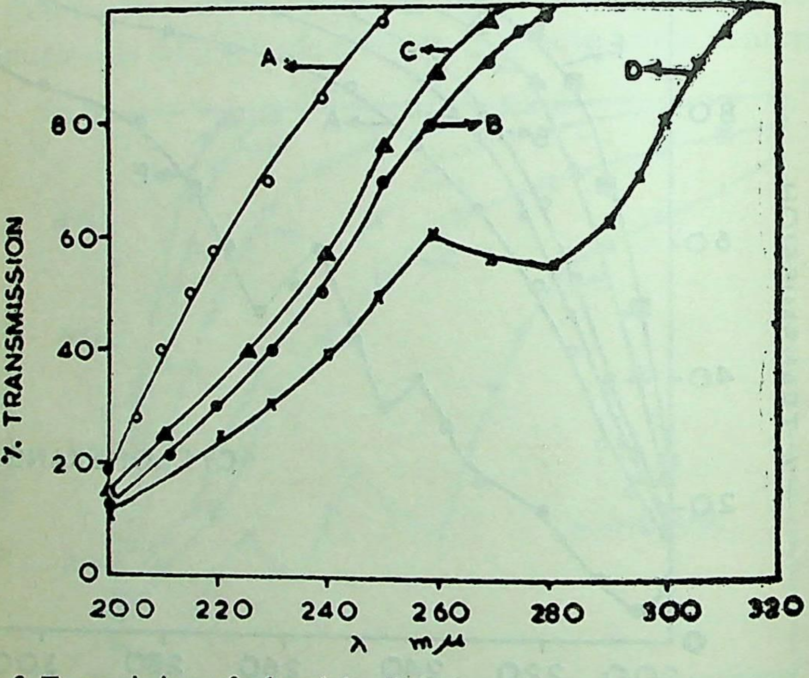

Figure 3–Transmission of ultraviolet light by :

A–pure n–Heptane.

B–pure methylcyclohexane.

C–Untreated n–Heptane.

D–Untreated methylcyclohexane.

n-heptane and methylcyclohexane:

A preliminary purification of these solvents was carried out by stirring with concentrated sulfuric acid, to remove aromatic compounds, washing with water, drying and distilling. The distillate was passed over the silica gel and aluminium oxide columns as before (Figure 4).

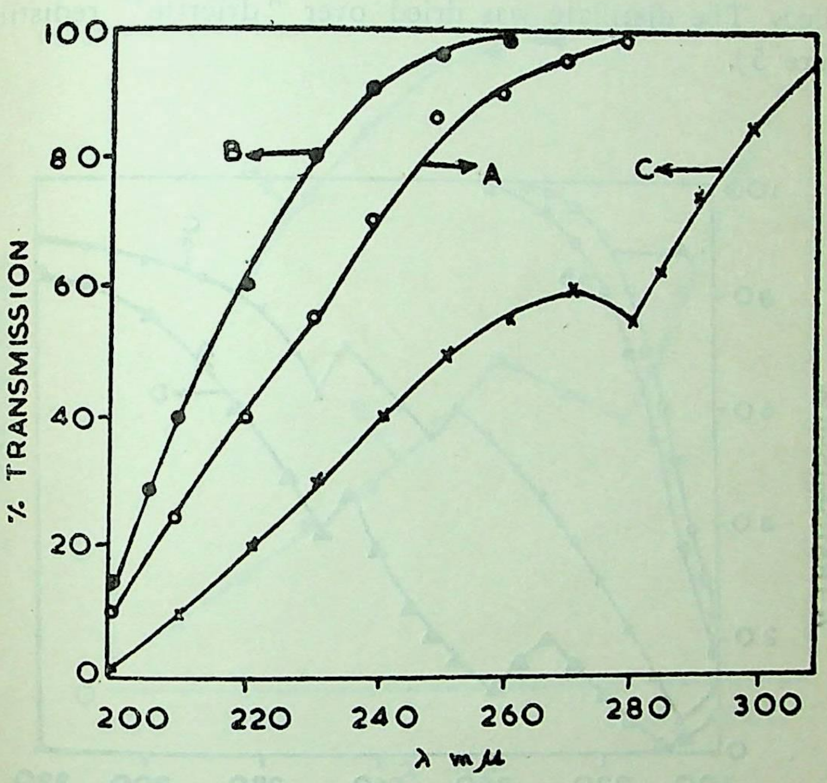

Figure 4–Transmission of ultraviolet light by :

A–Methanol purified by method of Pirlot.

B–Methanol purified by the process described on page 148.

C–Untreated methanol.

Methanol :

Methanol was purified by the method of Pirlot (loc. cit). A more transparent specimen was, however, obtained by the following process :

Methanol was refluxed with 10 gms./liter solution of sodium hydroxide, and 10 gms./liter solution of silver nitrate for twelve hours to remove the traces of aldehydes and then it was distilled. The distillate was dried over "drierite" redistilled. (Figure 5).

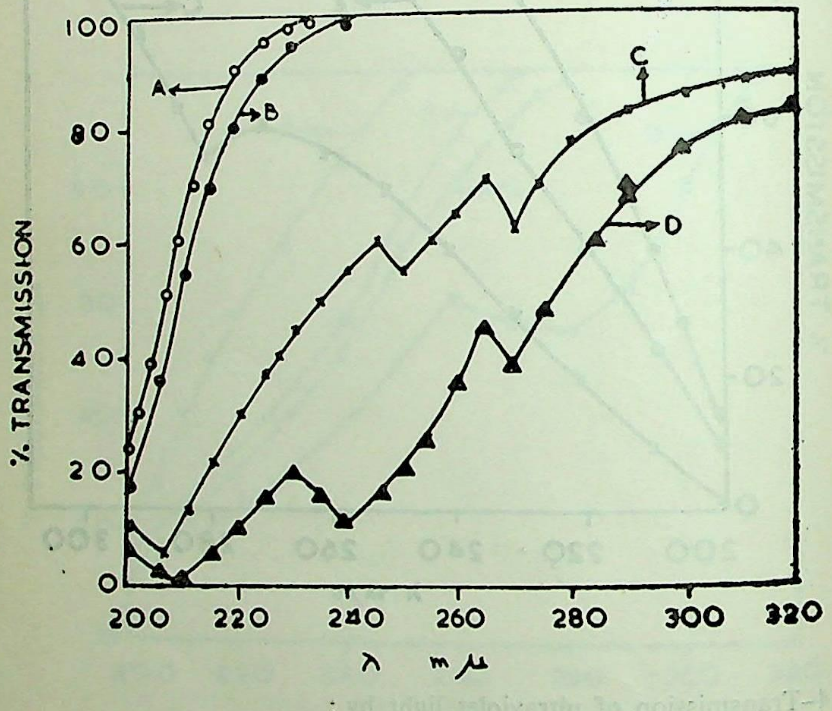

Figure 5–Transmission of ultraviolet light by ethyl alcohol.

A–purified by method of Leighton et. al.

B–purified by method of Pirlot.

C–purified by method of Gage and Wender.

D–untreated.

Isopropyl alcohol :

Isopropyl alcohol was purified by a process analogous to that used for methanol.

We thank the authorities of Gujarat University for the award of a research fellowship to one of us (M. H. Gandhi.)

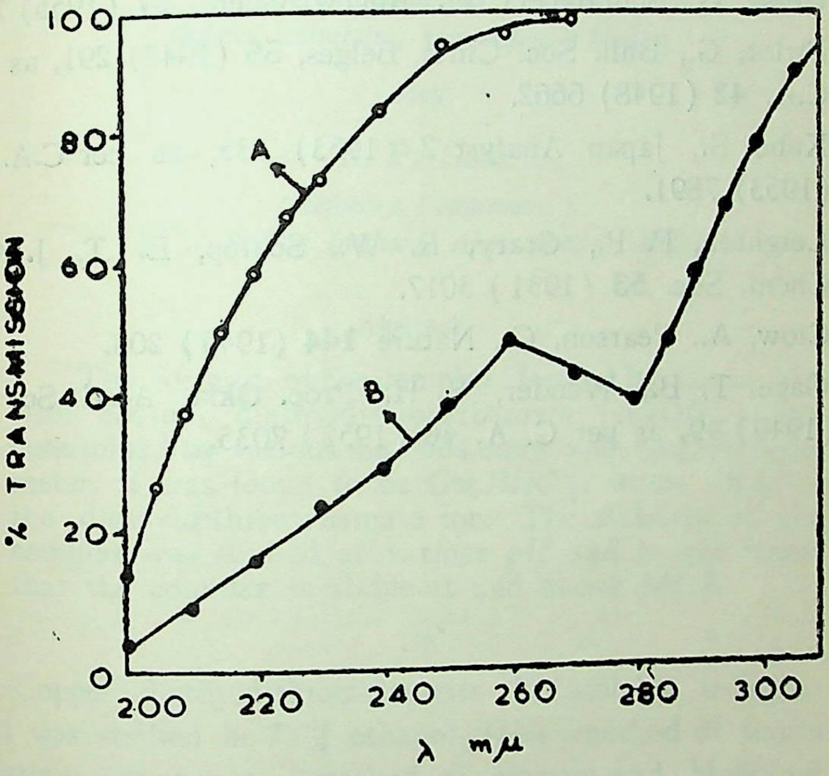

Figure 6–Transmission of ultraviolet light by isopropyl alcohol.
A–purified by process described on page 148.
B–untreated.

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COMPOSITION AND STABILITY OF COPPER-DIETHYLDITHIOCARBAMATE

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Abstract

The formula of the complex formed by cupric ions with sodium diethyldithiocarbamate (*NaDDC*) was determined by various methods employing spectrophotometer. It was found to be $Cu(DDC)_2$; where *DDC* is the diethyldithiocarbamate ion. The stability of the complex was studied at various *pH* and it was found that the complex is stable at and above *pH* 6.

* * *

Copper diethyldithiocarbamate is insoluble in water and so it was studied in 75% ethanol. Job's method of continuous variation[1], slope ratio method of Harvey and Manning[2] and mole ratio method of Yoe and Jones[3] were applied.

Experimental

Beckman spectrophotometer (*DU model*) was employed. The selection of wavelength for maximum absorbance was carried out with cupric ions plus excess of *NaDDC*. By trial it was found that the amount of *NaDDC* was sufficiently in excess. The wavelength for maximum absorbance was 430 $m\mu$. All the measurements were carried out at this wavelength. The data obtained by various methods are given in Tables I, II and III.

TABLE I

Formula of Copper-diethyldithiocarbamate (75% ethanol) Job's method

(*a*) Copper sulphate 0·001 *M* and *NaDDC* 0·001 *M*
(*b*) Copper sulphate 0·0005 *M* and *NaDDC* 0·0005 *M*.

No.	*ml. of* $CuSO_4$	*ml. of NaDDC*	*ml. of ethanol*	*Absorbance at* λ 430	
				A	*B*
1.	0·0	5·0	15·0	0·014	0·003
2.	0·5	4·5	15·0	0·360	0·162
3.	1·0	4·0	15·0	0·707	0·332
4.	1·3	3·7	15·0	0·895	0·438
5.	1·5	3·5	15·0	0·995	0·505
6.	1·6	3·4	15·0	1·067	0·537
7.	1·7	3·3	15·0	1·030	0·500
8.	1·8	3·2	15·0	0·975	0·495
9.	2·0	3·0	15·0	0·912	0·455
10.	3·0	2·0	15·0	0·500	0·260
11.	4·0	1·0	15·0	0·190	0·098
12.	5·0	0·0	15·0	0·030	0·022

TABLE II

Formula of Copper-diethyldithiocarbamate (75% ethanol) Mole Ratio method

(*a*) Copper sulphate 0·002 M and *NaDDC* 0·002 M
(*b*) Copper sulphate 0·001 M and *NaDDC* 0·001 M

No.	*ml. of* $CuSO_4$	*ml. of NaDDC*	*ml. of* H_2O	*ml. of ethanol*	*Absorbance at* λ 430	
					A	*B*
1.	0·6	0·0	4·4	15·0	0·003	0·003
2.	0·6	0·3	4·1	15·0	0·115	0·055
3.	0·6	0·6	3·8	15·0	0·305	0·140
4.	0·6	0·9	3·5	15·0	0·535	0·250
5.	0·6	1·0	3·4	15·0	0·605	0·290
6.	0·6	1·1	3·3	15·0	0·675	0·325
7.	0·6	1·2	3·2	15·0	0·725	0·365
8.	0·6	1·3	3·1	15·0	0·805	0·385
9.	0·6	1·4	3·0	15·0	0·820	0·385
10.	0·6	1·6	2·8	15·0	0·825	0·405
11.	0·6	1·8	2·6	15·0	0·815	0·427
12.	0·6	2·0	2·4	15·0	0·830	0·400
13.	0·6	2·5	1·9	15·0	0·815	0·413
14.	0·6	3·0	1·4	15·0	0·813	0·405
15.	0·6	4·0	0·4	15·0	0·810	0·405

TABLE III

Copper sulphate+NaDDC (75% ethanol) Slope Ratio method

Excess of NaDDC

No.	*ml. of* $CuSO_4$ 0·005*M*	*ml. of NaDDC* 0·05*M*	*ml. of* H_2O	*ml. of ethanol*	*Absorbance at* λ 430	*Absorbance corrected for blank*
1.	0·0	0·5	4·5	15·0	0·020	0·000
2.	0·1	0·5	4·4	15·0	0·370	0·350
3.	0·2	0·5	4·3	15·0	0·677	0·657
4.	0·3	0·5	4·2	15·0	1·020	1·000
5.	0·4	0·5	4·1	15·0	1·315	1·295
6.	0·5	0·5	4·0	15·0	1·687	1·667

Excess of $CuSO_4$*

No.	*ml. of* $CuSO_4$ 0·05*M*	*ml. of NaDDC* 0·005*M*	*ml. of* H_2O	*ml. of ethanol*	*Absorbance at* λ 430	*Absorbance corrected for blank*
1.	0·5	0·0	4·5	15·0	0·000	0·000
2.	0·5	0·1	4·4	15·0	0·040	0·040
3.	0·5	0·2	4·3	15·0	0·085	0·085
4.	0·5	0·3	4·2	15·0	0·165	0·165
5.	0·5	0·4	4·1	15·0	0·238	0·238
6.	0·5	0·5	4·0	15·0	0·312	0·312

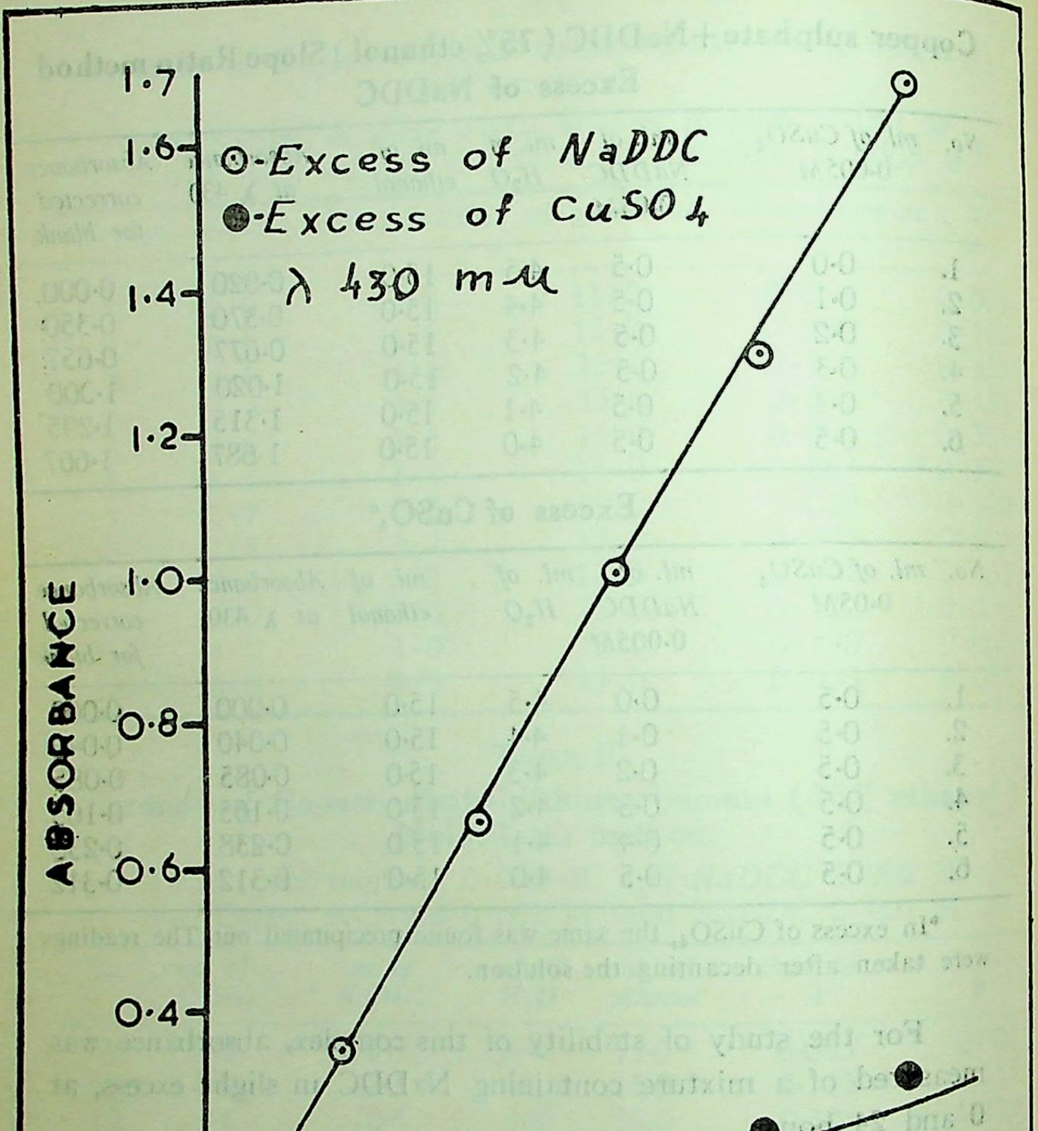
*In excess of $CuSO_4$, the same was found precipitated out. The readings were taken after decanting the solution.

For the study of stability of this complex, absorbance was measured of a mixture containing NaDDC in slight excess, at 0 and 24 hours.

Discussion

In Job's method, it was found that the maximum absorbance for both the sets corresponded to the mixture having $CuSO_4$ and *NaDDC* in the concentration ratio 1:2, i.e., the formula of the complex is $Cu(DDC)_2$.

In the mole ratio method also for both the sets, there was a sharp break in the curve when *NaDDC* was 1·2 ml., i.e.,


⊙-Excess of NaDDC
●-Excess of CuSO4
λ 430 mμ
ABSORBANCE
1.7
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.1
0.2
0.3
0.4
0.5
ml. of 0.005 M CuSO4 or NaDDC

the concentration ratio of $CuSO_4$ and $NaDDC$ was 1:2. This confirms the conclusions obtained from Job's method.

In the slope ratio method, the results are different. The ratio of the slopes obtained from the curves of absorbance against ml. of $CuSO_4$ or $NaDDC$, was not 1:2 (see figure) i.e., the complex is not 1:2. This must be due to the fact that when copper is in excess there is formation of 1:1 complex which has maximum absorbance at 380 $m\mu$ (as observed by Janssen[4]). Hence, the value of the slope with excess of $CuSO_4$ may be different from that expected at 430 $m\mu$. Thus, this method may be considered unsuccessful for the study of formula in present case. Regenass[5] has observed the formation of 1:1 complex in the case of copper dipropyl dithiocarbamate. From the other two methods, it can be concluded that the formula of the complex between copper sulphate and $NaDDC$ is $Cu(DDC)_2$.

The absorbance measurements at various pH, at 0 and 24 hours led to the conclusion that it is stable at and above pH6. Below this pH, it is unstable as indicated by the decrease in absorbance.

None of the methods was successful for calculating stability constants. This may be due to (*i*) high stability of the complex, (*ii*) very low solubility of the complex even in 75% ethanol, and (*iii*) decomposition of the complex and $NaDDC$ at low pH.

Thanks are due to Professor A. M. Trivedi for interest in the work and Ahmedabad Education Society for laboratory facilities.

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CYTOCHEMICAL LOCALIZATION OF ENZYMES IN NORMAL & IRRADIATED ROOT TIPS OF MALVASTRUM COROMENDELIANUM GREKE

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Abstract

The localisation of acid phosphatase, alkaline phosphatase and succinate dehydrogenase has been studied in the root tips of *Malvastrum coromendelianum.* For the localisation of enzymes fresh hand cut sections of the root tip and smears were used. The acid phosphatase was found to be localized in the cytoplasmic inclusions probably mitochondria and lysosome, as well as in the nucleus. The alkaline phosphatase activity could be localized in the nucleus only. The meristematic cells showed better activity than cells below it. The succinate dehydrogenase activity could be localized irrespective of the presence or absence of added succinate. This is probably due to the presence of enough succinate in cells of enzymatic activity. The maximum activity could be noticed in the root cap region. The effect of ultraviolet irradiation on the enzymatic activity was also studied. There was no enzyme when the seedlings were exposed to the ultraviolet irradiation for four hours.

Cytochemical localization of enzymes in normal & irradiated root tips of Malvastrum coromendelianum

INTRODUCTION

The biochemical behaviour and histochemical localization of biocatalysts of the seeds of desert plants have been worked out to a very limited extent. Ecophysiological aspect of desert seed germination has been reviewed by Chatterji (1966), Sharma & Roy (1966) and Shah (1960) have studied the effect of irradiation on the activity of enzymes. Shah (1960) working on ***Tulbaghia violacea*** failed to observe any noticable effect of irradiation on the activity of acid and alkaline phosphatases.

In the present case, activity of acid phosphatase, alkaline phosphatase and succinate dehydrogenase has been studied in germinating seedlings of *Malvastrum coromendelianum* by histochemical technique.

MATERIALS & METHODS

The seeds of *Malvastrum coromendelianum* were collected from the university campus in 1966. The seeds were kept on moist filter paper in sterilized petridishes and were allowed to germinate in an air cooled room at a temperature of 23°C. The seedlings were exposed to ultraviolet irradiation for four hours. Longitudinal sections of the fresh material were cut and processed to study different enzymes. Smears of the root tips were also prepared with acetocarmine and Janus Green B to study the nucleus and mitochondria.

Gomori's (1952) method was used for the localization of the activity of acid phosphatase and alkaline phosphatase. The technique of Nachlas, Tsow, de Souza, Chang and Saligman (1957) was followed as given by Gomori (1957), for the localization of succinate dehydrogenase. Controls consisted of (*i*) boiled sections, (*ii*) medium minus substrate, and (*iii*) ·1 M NaF in medium for phosphatases. The sections were treated with phosphate buffer (0·1 M) at pH 7·6 for 5 minutes before incubation to destroy the endogenous substrate of the tissue. The incubation medium was boiled before incubation of the tissues in the said medium along with NaCN (0·1 M).

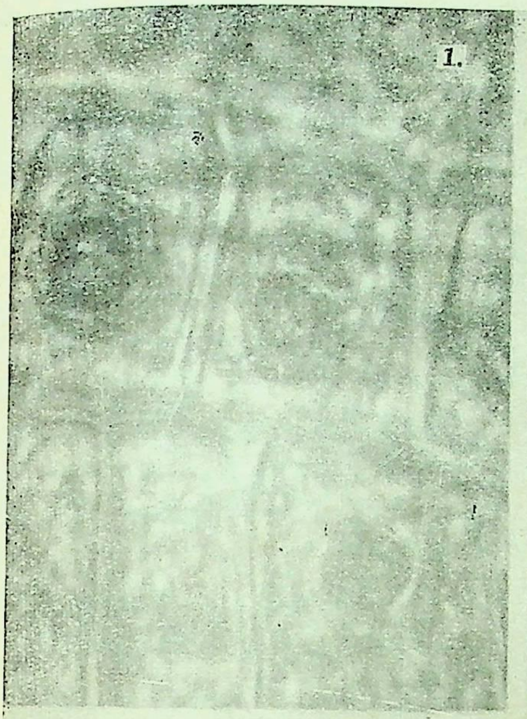
RESULTS

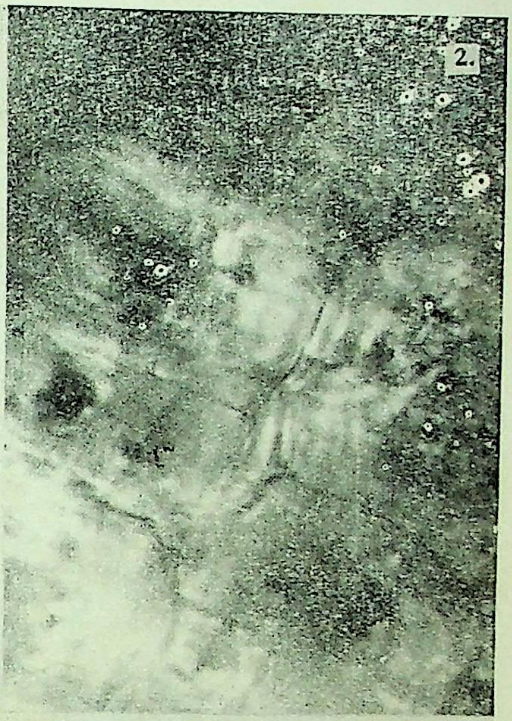
The distribution of different enzymes in root tips is shown in Table I. The acid phosphatase activity appeared as black deposits in the cytoplasm and the nucleus (Fig. 2). The activity of the enzyme was dense near the root tip. The enzyme was found to be distributed both in the cytoplasm and the nucleus but in cytoplasm there was intense activity. The activity of acid phosphatase was remarkably good in the meristematic region and phloem. A comparatively poor activity could be noticed in the cortex and the pith.

No difference in acid phosphatase activity could be noticed in irradiated and unirradiated seedlings.

The activity of alkaline phosphatase appeared as black depositions in the nucleus (Fig. 3). The activity of the enzyme was comparatively dense in the nucleolus. The enzymatic activity appeared more in the regions of meristem, pericycle, endodermis and phloem. In cortex and pith the activity was poor. Ultraviolet irradiation did not show any effect on the activity of alkaline phosphatase.

The maximum activity of succinate dehydrogenase could be demonstrated in the meristematic region, and root cap. The activity was comparatively better in epidermis, pericycle endodermis and phloem. The sites of enzymatic activity appeared as purple red granules in the cytoplasm (Fig. 4). No detectable effect of irradiation could be observed on the activity of succinate dehydrogenase. The succinate dehydrogenase could be localized in the absence or presence of added succinate.


1.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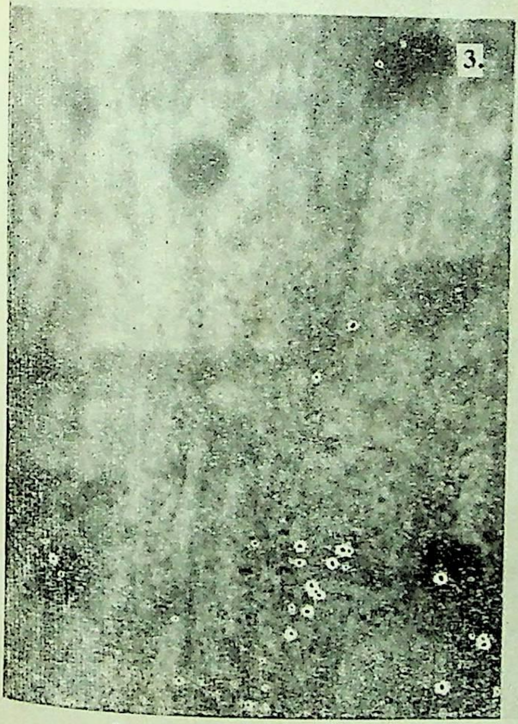
3.

4.

Fig. 1 : L. S. of the root tip of M. Coromendelianum, no activity of acid phosphatase could be seen in control set. × 550.
For legends of Figs. 2, 3 and 4, see footnote on page 160.

Results presented in Table I clearly indicate that the order of the intensity of the enzymatic activity was meristematic region, phloem, pericycle, endodermis, epidermis cortex and pith. Practically no enzymatic activity could be demonstrated in xylem.

DISCUSSION

The alkaline phosphatase was found to be localized in the nucleus, as has been reported previously by Danieli (1953); Sharma et. al. (1953) and Shah (1960). While the activity of alkaline phosphatase in nucleus is well established, there are conflicting reports about the intracellular distribution of acid phosphatase. Glick and Fischer (1946) and McGregor and Street (1953) have reported the distribution of the enzyme in the nucleolus, nuclei, cytoplasm and cell wall. On the basis of studies with fresh material, Avers and King (1960) and Dyar (1950) have reported its distribution in the cytoplasm. Jensen (1956) and Zalokar (1960) have reported mitochondria to be the sites of the enzyme activity, but Holt (1956) has reported its distribution in lysosomes also. Kathju and Tewari (1968) have reported nucleus to be the site of activity for acid phosphatase in *Cajanus indious.* In case of *Malvastrum coromendelianum* the enzyme appeared to be localized in the nucleus and cytoplasm. Since the number of particles showing phosphatase activity exceeded the number of Janus green B stainable bodies, the mitochondria, it appears that this enzyme has extra mitochondrial, distribution in the cytoplasm, which might be the lysosomes.

The activity of succinate dehydrogenase was localized by Nitro BT. This enzyme was present in mitochondria. Succinate dehydrogenase could not be localized in the nucleus as has been

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Fig. 2 : L. S. of the root showing acid phosphatase activity in the cytoplasm & the nucleus × 550.

Fig. 3 : L. S. of the root showing alkaline phosphatase activity in the nucleus × 1000.

Fig. 4 : Succinate dehydrogenase activity is evident in the form of black deposits in the cytoplasm × 1000.

TABLE I

Distribution of enzymes in the root tip

Enzyme	*Meristematic region*	*Epidermis*	*Cortex*	*Pericycle & Endodermis*	*Xylem*	*Phloem*	*Pith*
acid phosphatase	++	++	+	++	–	+++	+
alkaline phosphatase	+++	+	+	+++	–	+++	+
succinate dehydrogenase	+++	++	+	++	–	++	+

+++ intense;

++ good;

+ poor;

– no activity.

reported by De et. al. (1962). This enzyme activity was observed in the controls in which substrate, sodium succinate was not added. However, in control in which the sections were previously boiled, this enzyme could not be localised. This probably is due to the presence of enough succinate in the plant itself. When the endogenous substrate was destroyed no activity could be demonstrated in the absence of the added substrate.

The enhanced enzymatic activity in the meristematic region is due to high rate of metabolic activity in the region. The phosphorolytic degradation of the stored metabolites in the meristematic region and their transport and further transformation in transporting channel is the cause of the next higher activity in the cells of phloem. The enzymatic activity in the pericycle, endodermis, epidermis, cortex and pith is due to normal metabolic transformations. Due to the absence of metabolic operations in the xylem no enzymatic activity could be possible.

In the present case no effect could be detected on the activity of three enzymes studied after the seedlings were exposed to UV–irradiation. Shah (1960) was unable to detect any effect on the activity of acid and alkaline phosphatases in *Tulbaghia violacea.*

ACKNOWLEDGMENT

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THE MOLECULAR STRUCTURE OF PHENOLS AND THEIR INHIBITOR ACTION ON CORROSION OF 63/37 BRASS IN SODIUM HYDROXIDE SOLUTIONS

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Abstract

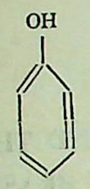
Phenol, dihydric and trihydric phenols, amino phenols, β–naphthol and 8-hydroxy quinoline have been investigated as corrosion inhibitors for 63/37 brass in sodium hydroxide solutions. Substitution of hydrogen atom in phenol by — OH or — NH_2 group is beneficial to inhibitor action, whereas introduction of a — CHO or — CH_3 group is not beneficial. Best inhibitor action is shown by meta substituted compounds, namely resorcinol, phloroglucinol and m-amino phenol.

The present study has been undertaken to study the inhibitor action of various phenols and to correlate the inhibitor action with their molecular structure.

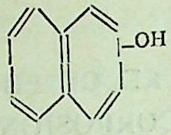
With this aim, the corrosion of 63/37 brass in 0·2N, 0·5N and 1·0N sodium hydroxide solutions and the inhibitor action of various phenols has been studied by the loss in weight method. The specimens (6 cm × 3 cm, thickness 28 S.W.G.) were completely immersed for five days in sodium hydroxide solutions at 35 ± 1°C. Corrosion tests and cleaning of specimens after corrosion were carried out as described in our previous publications.[1]

The Effect of Nucleus

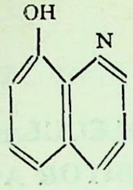
To investigate the effect of nucleus to which the phenolic OH group is attached, the inhibitor action of phenol, β–naphthol and 8–hydroxyquinoline was



Phenol



β-naphthol



8-hydroxy quinoline

investigated : The results are plotted in Figure 1. From this figure, it can be seen that the order of efficiency is phenol > β-naphthol > 8-hydroxyquinoline. It is quite probable that the retardation of corrosion of 63/37 brass by β-naphthol and 8-hydroxyquinoline is due to their chelating action with Copper and Zinc. Aloy[2] has observed that β-naphthol reacts with cupric ions to give a blue colour. In fact, we have observed that when a brass specimen is immersed in sodium hydroxide solution containing β-naphthol, the solution becomes bluish coloured

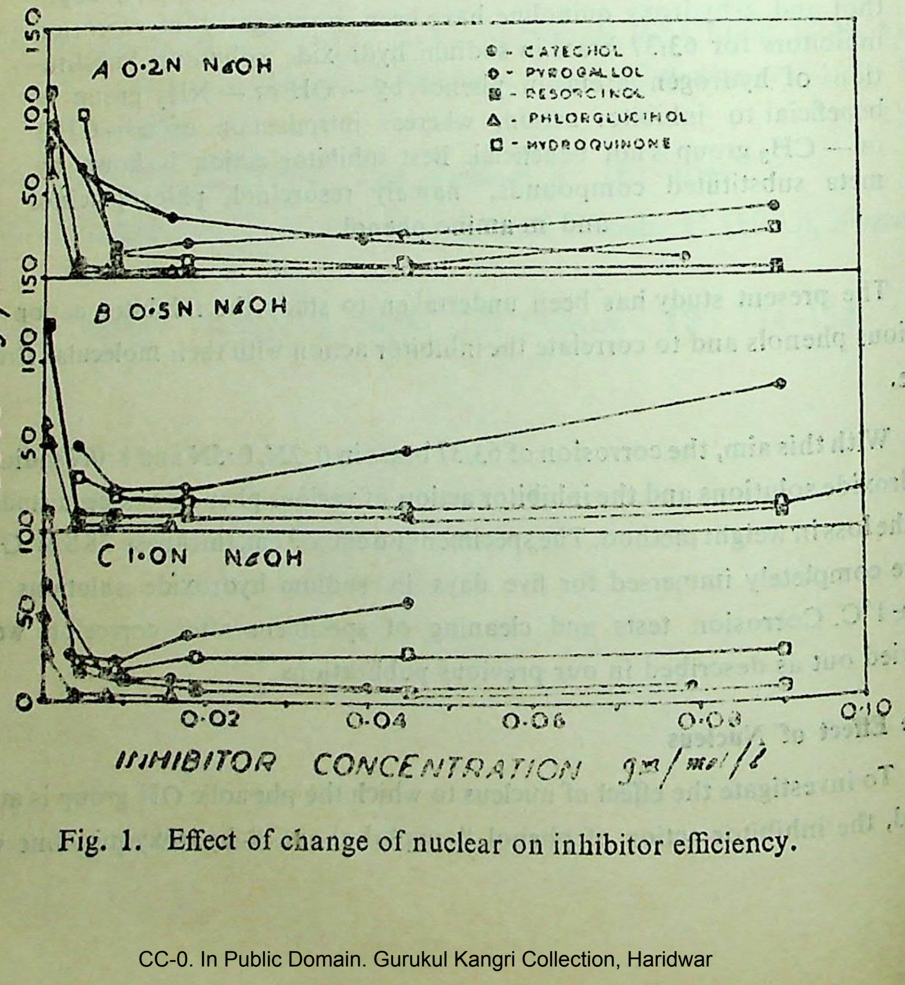
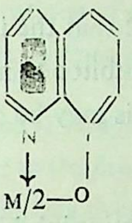


Fig. 1. Effect of change of nuclear on inhibitor efficiency.

and that at the end of five days, the metal specimens are covered with coloured films.

8-hydroxyquinoline is a wellknown chelating agent. It forms a green chelate with copper which is precipitated in pH range 5·33–14·55. and a greenish yellow precipitate with *Zinc* which is precipitated in the range 4·6–13·4. Both these complexes can be represented by the sturcture.

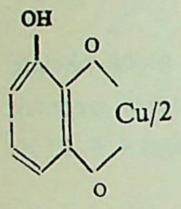


We have observed that at the end of five days. the metal specimens were covered with yellow coloured films.

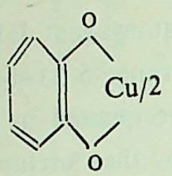
Another important aspect worth studying is the effect of diverse substituents in phenol in ortho, meta or para positions with respect to phenolic OH group on the inhibitor efficiency of such substances. With this aim, compounds having methyl, aldehyde, hydroxyl and amino group as substituents in phenolic nucleus were studied. The action of salicylaldehyde and meta cresol indicate that the introduction of an aldehyde or a methyl group in phenol is not very beneficial and hence the corresponding meta and para hydroxybenzaldehydes and ortho and para cresols were not investigated further.

Effect of Ortho Substitution

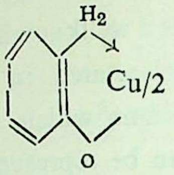
To investigate the effect of ortho substitution in phenols, on their inhibitor action, catechol, o-aminophenol, salicylaldehyde and pyrogallol were studied. The results are plotted in Figure 2. It can be seen that of all the four substances, pyrogallol is the most efficient in retarding the corrosion of 63/37 brass. The order of efficiency for the remaining three disubstituted compounds being catechol > salicylaldehyde > o-aminophenol. All the four substances are marked by their capacity to form metal chelates. Structures of their cupric complexes can be represented by



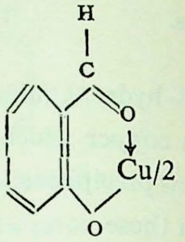
Pyrogallol



Catechol



o-aminophenol



Salicylaldehyde

It can be noted from Figure 2 that the inhibitor action of o-aminophenol decreases with the increase in inhibitor concentraction and in some cases, it even accelerates the corrosion. This may be due to the solubility of the chelate formed.

Salicylaldehyde is not an effective inhibitor of corrosion of 63/37 brass at the concentrations studied, which shows that the complex formed does not give a protective film under the conditions of study.

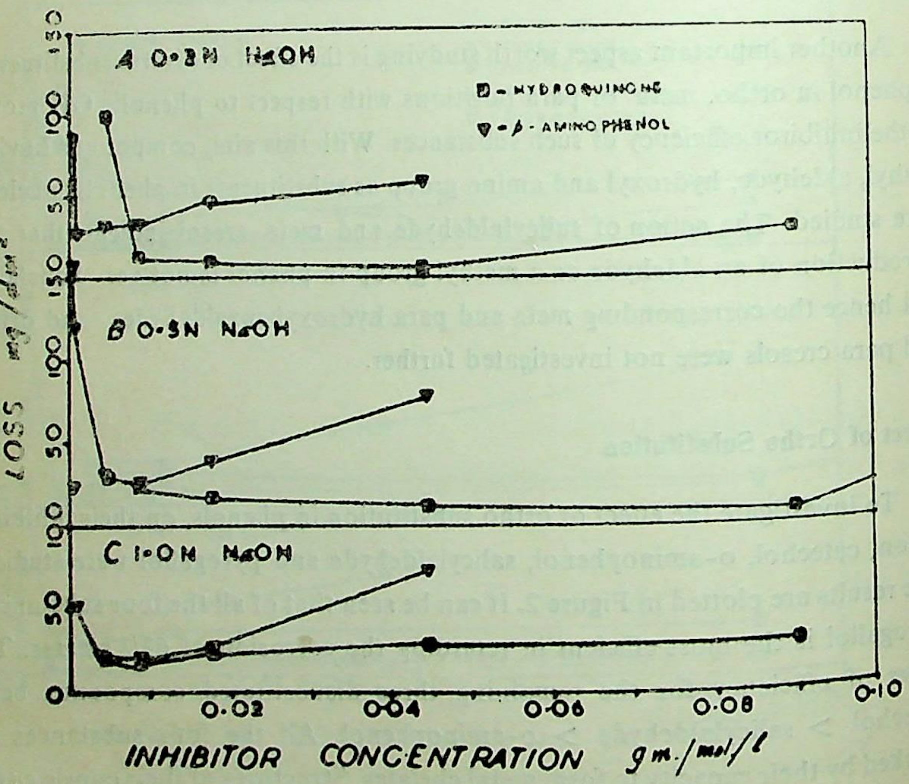


Fig. 2. Effect of ortho substitution in phenols on their inhibitor efficiency.

The efficiency of catechol is maximum at 0·009 gm/moles/liter of catechol and with further increase in its concentration, the efficiency of catechol falls off.

It has been suggested by Putilova, Balezin and Barannik[3] that at higher concentrations many organic substances retard corrosion to a lesser degree and some times becomes accelerators of corrosion. It is possible that in the present case, at higher inhibitor concentrations the reaction between the metal, the inhibitor and the corrosive medium becomes easier, creating conditions for the formation of distinct compounds as opposed to surface compounds. Thus more metal is used than at low concentrations of the inhibitor, when the amount of inhibitor is insufficient to form this compounds.

Protection afforded by pyrogallol is not adversely affected by increase in its concentration. This might be due to the fact that pyrogallol is a reducing agent and thus it may render the medium less corrosive by removing oxygen. In the presence of pyrogallol the metal specimens are covered by brown films. It is therefore, probable that the good inhibitor action of pyrogallol is due to a combination of its capacity as a reducing agent as well as as a chelating agent.

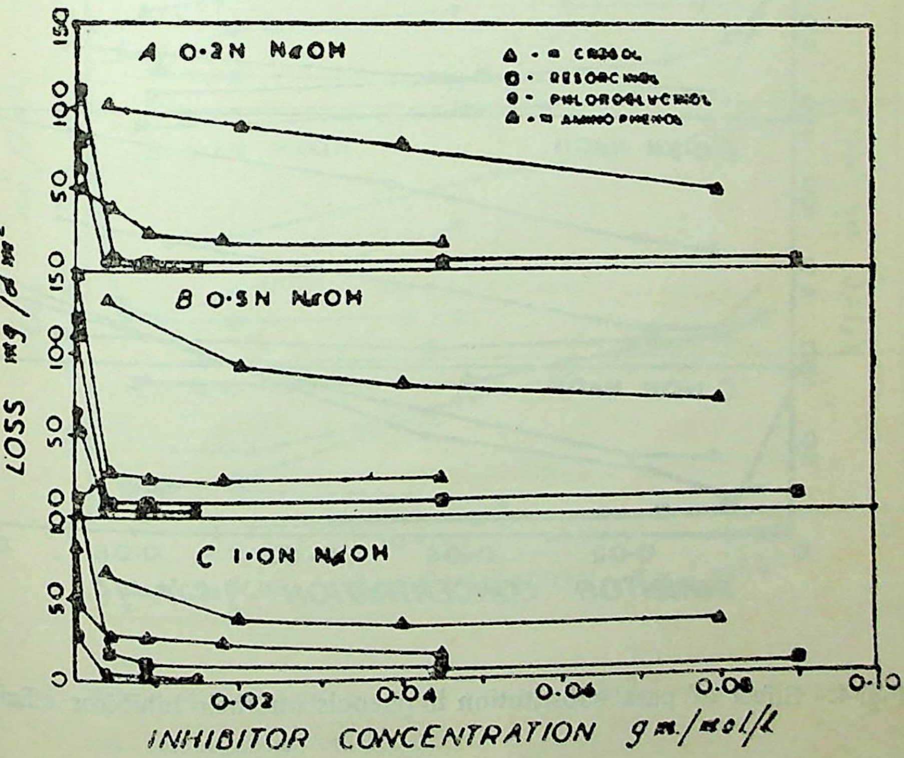


Fig. 3. Effect of meta substitution in phenols on their inhibitor efficiency.

Effect of Meta Substitution

Figure 3 shows the effect of substituents in meta position of phenol on their inhibitor action. It can be seen that an introduction of methyl group in phenol is not very favourable for increasing inhibitor action, whereas introduction of an amino or a hydroxyl group in meta position with respect to the OH group renders the substance an effective inhibitor for the corrosion of 63/37 brass in sodium hydroxide solutions. Resorcinol is thus, an excellent inhibitor which affords 95% protection to brass at all the alkali concentrations studied and its inhibitive property is not adversely effected by increase in inhibitor concentration. In presence of resorcinol, the metal specimens are covered with reddish yellow coloured films. which indicates that the protection afforded is due to the formation of a protective layer.

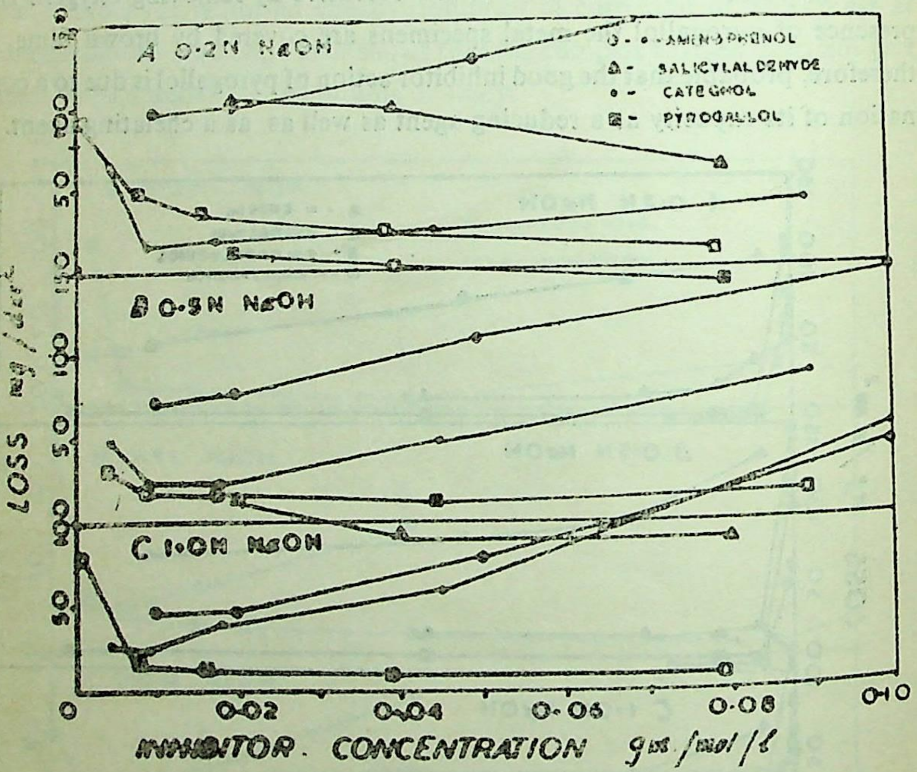


Fig. 4. Effect of para substitution in phenols on their inhibitor efficiency.

Effect of Para Substitution

Figure 4 shows the effect of substitution in para position of phenol on inhibitor action. The mechanism of inhibition in this case is rather complicated as both the substances are reducing agents as well as chelating agents.

Effect of the Position of OH Group

Figure 5 shows the effect of the position of OH groups in dihydric and trihydric phenols on their inhibitor action. The highest efficiency is shown by the meta substituted phenols, namely phloroglucinol and resorcinol. In 0.2N—1·0N alkali solutions, phloroglucinol affords nearly complete protection to 63/37 brass at as low a concentration as 0·004 gm/mole/liter and thereafter its efficiency is nearly constant. The structural formula of phloroglucinol can be

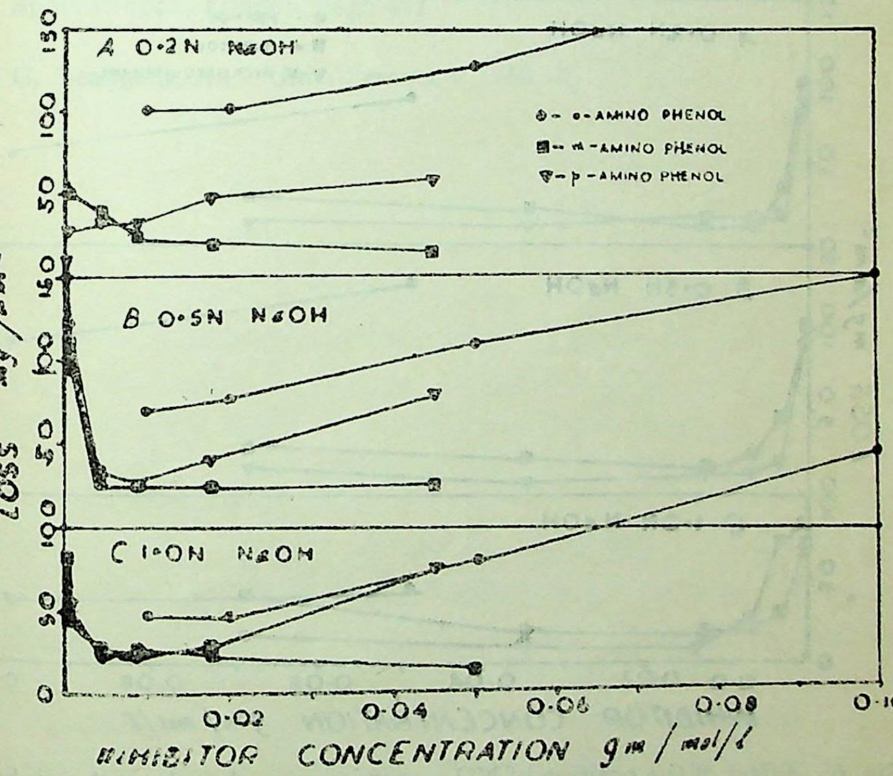
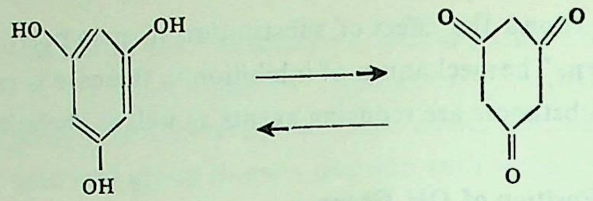


Fig. 5. Effect of the position of OH group in dihydric and trihydric phenols on their inhibitor efficiency.

represented by :



and it is probable that the triketo form is adsorbed over the metal surface giving an excellent protection.

Effect of NH_2 Group

A comparison of the performance of ortho, meta and para amino phenols (Figure 6) shows that as seen in case of OH Group, in the case of $-NH_2$ group also, meta substituted compound is most efficient in retarding the corrosion.

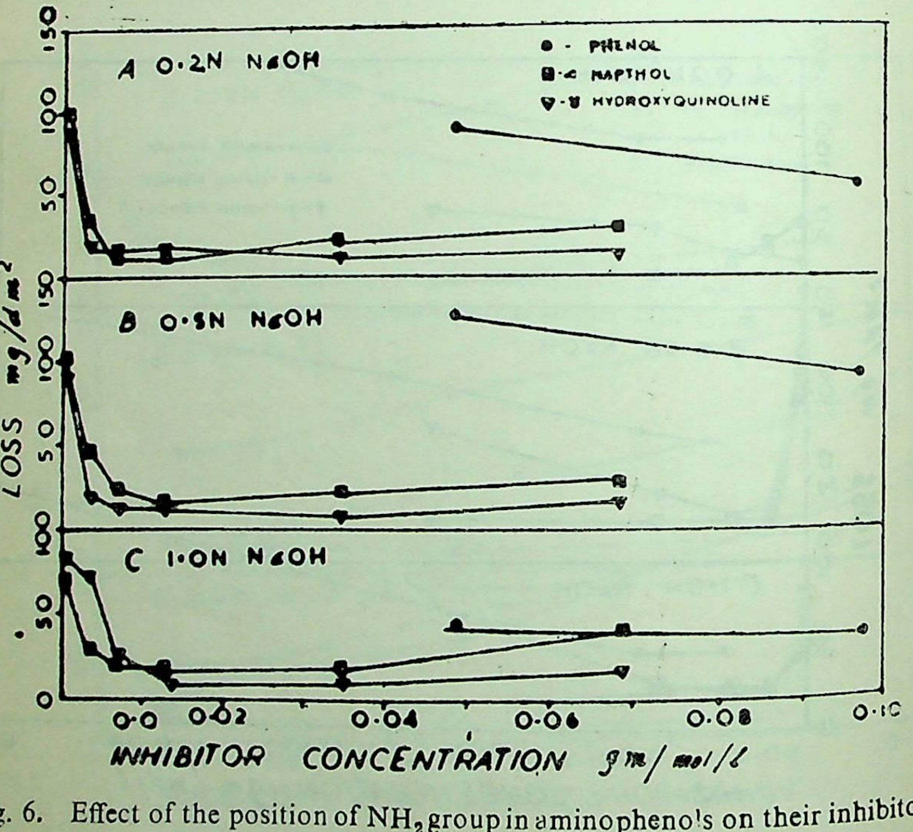


Fig. 6. Effect of the position of NH_2 group in aminophenols on their inhibitor efficiency.

We thank the Council of Scientific and Industrial Research for the award of a Senior Research Assistantship to one of us. (Y.C.S.)

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SPECTROPHOTOMETRIC DETERMINATION OF FERRIC IONS BY 4-HYDROXY-3-PROPIONYL OXIME SODIUM BENZOATE

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While a number of hydroxy ketoximes have been investigated as analytical reagents, 4-hydroxy-3-propionyl oxime benzoic acid is not investigated as a colorimetric reagent so far.

This article reports the use of this compound as a reagent for the spectrophotometric determination of iron.

Experimental :

Ferric nitrate solution :

0·1M solution of ferric nitrate was prepared by dissolving 40·389 gms. of ferric nitrate nonahydrate in distilled water to get one litre solution. Dilute solutions required in the work were prepared freshly from the stock solution.

Reagent solution :

4-hydroxy-3-propionyl benzoic acid was synthesized by Fries migration of 4-propionoxy benzoic acid. It was then refluxed with hydroxylamine to get the oxime. 2·09 gms. of oxime was added to about 250 c.c. distilled water. 0·84 gm. Analar sodium bicarbonate was added to the mixture and warmed to get a clear solution. The cooled solution then was diluted to one litre to get 0·01M reagent solution. It remains stable for several weeks.

Effect of pH ;

It was observed that the absorbence was affected by pH changes. The complex is stable between pH 3·5 and 5·5. The colour is red between pH 3 and 6 and reddish brown above pH 6. The optimum pH for absorbence is 4·0 to

4·8. The spectral characteristics of the complex at different pH values are shown in Fig. 1.

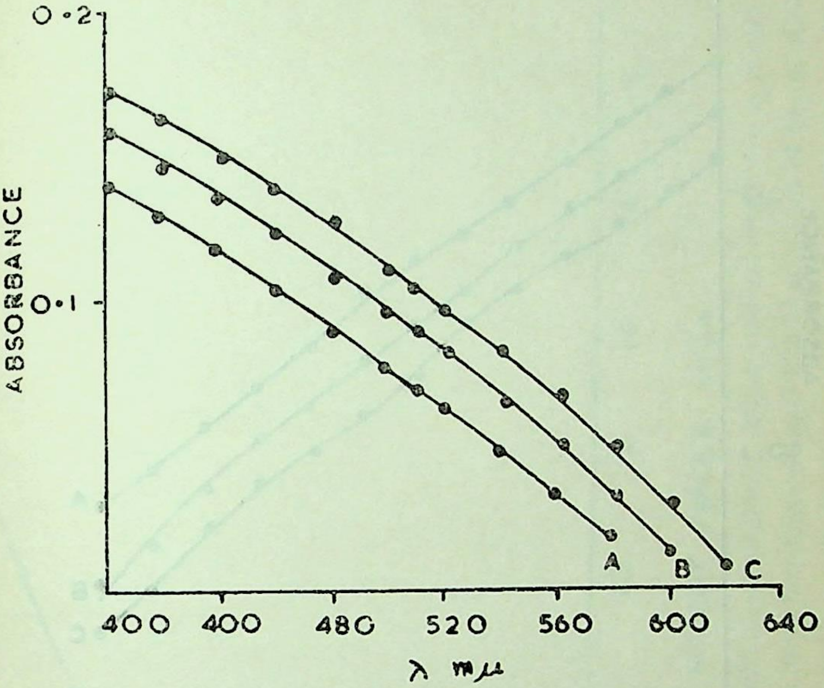

Figure 1 .. Spectral Characteristics of the ferric–4–hydroxy–3–propionyl oxime sodium benzoate complex at different pH values.

A. pH 4·0 to 4·8 B. pH 5·2 C. pH 3·6

(2 ml. 0·002M Ferric nitrate +1 ml. 1M $NaClO_4$+20 ml. 0·002M 4–hydroxy–3–propionyl oxime sodium benzoate. Final volume 50 ml.).

Absorption Measurements :

The absorption spectra of mixtures of equimolecular solutions of ferric nitrate and the reagent in the ratios 1 : 1, 1 : 2 and 1 : 3 at different pH values were observed in the range of 400 mu to 625 mu. After adjusting the desired pH, the absorbences of the mixture were measured after 15 minutes. Between pH values 3·5 and 5·5 the colour of the complex is stable for two hours. It is stable in the concentration-range of 1·12 p.p.m., to 13·44 p.p.m. above which it tends to precipitate. The solution obeys Beer's law in this range.

The absorbences of the mixtures at pH 4·2 are shown in Fig. 2.

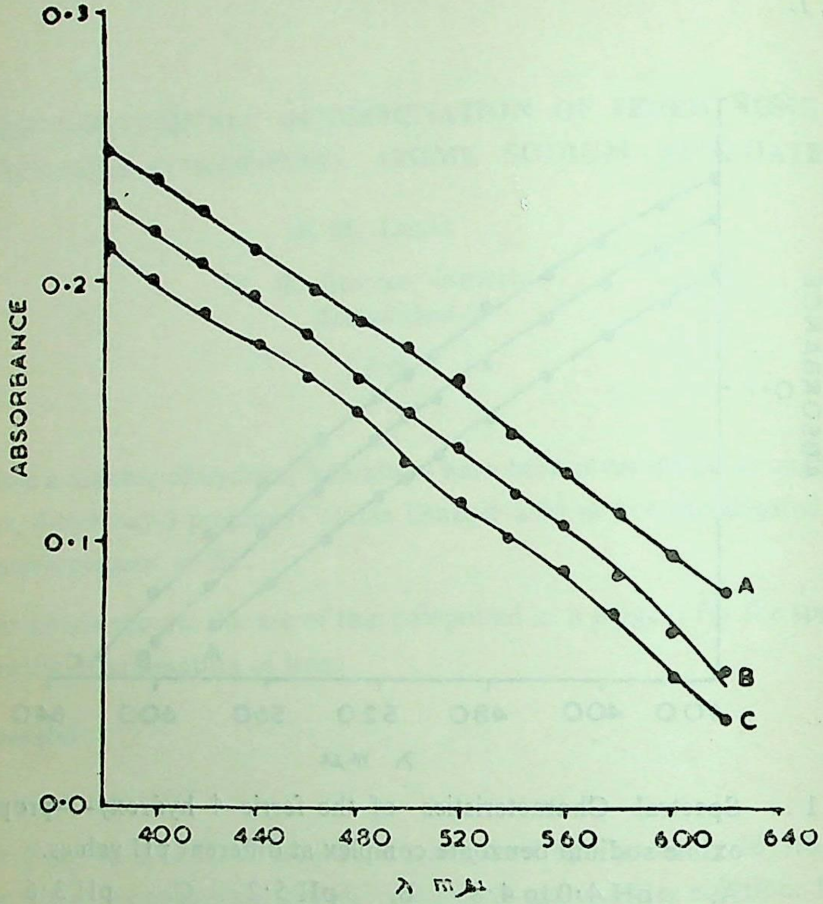

Figure 2 .. Absorption Spectrum of the ferric 4–hydroxy–3–propionyl oxime sodium benzoate complex at pH 2·9.

A. 2 ml. 0·002M Ferric nitrate + 2 ml. 0·002M 4–hydroxy–3–propionyl oxime sodium benzoate.

B. 2 ml. 0·002M Ferric nitrate + 4 ml. 0·002M 4–hydroxy–3–propionyl oxime sodium benzoate.

C. 2 ml. 0·002M Ferric nitrate + 6 ml. 0·002M 4–hydroxy–3–propionyl oxime sodium benzoate.

Composition of the Complex :

(*a*) *The method of continuous variation* :

The reagent is completely transparent to light in the spectra range studied, however, corrections were made for absorption due to ferric ions, by measuring the absorbence of complex against blank solutions of corresponding concentration of Ferric nitrate at pH 4·2. The results obtained are shown in Fig. 3.

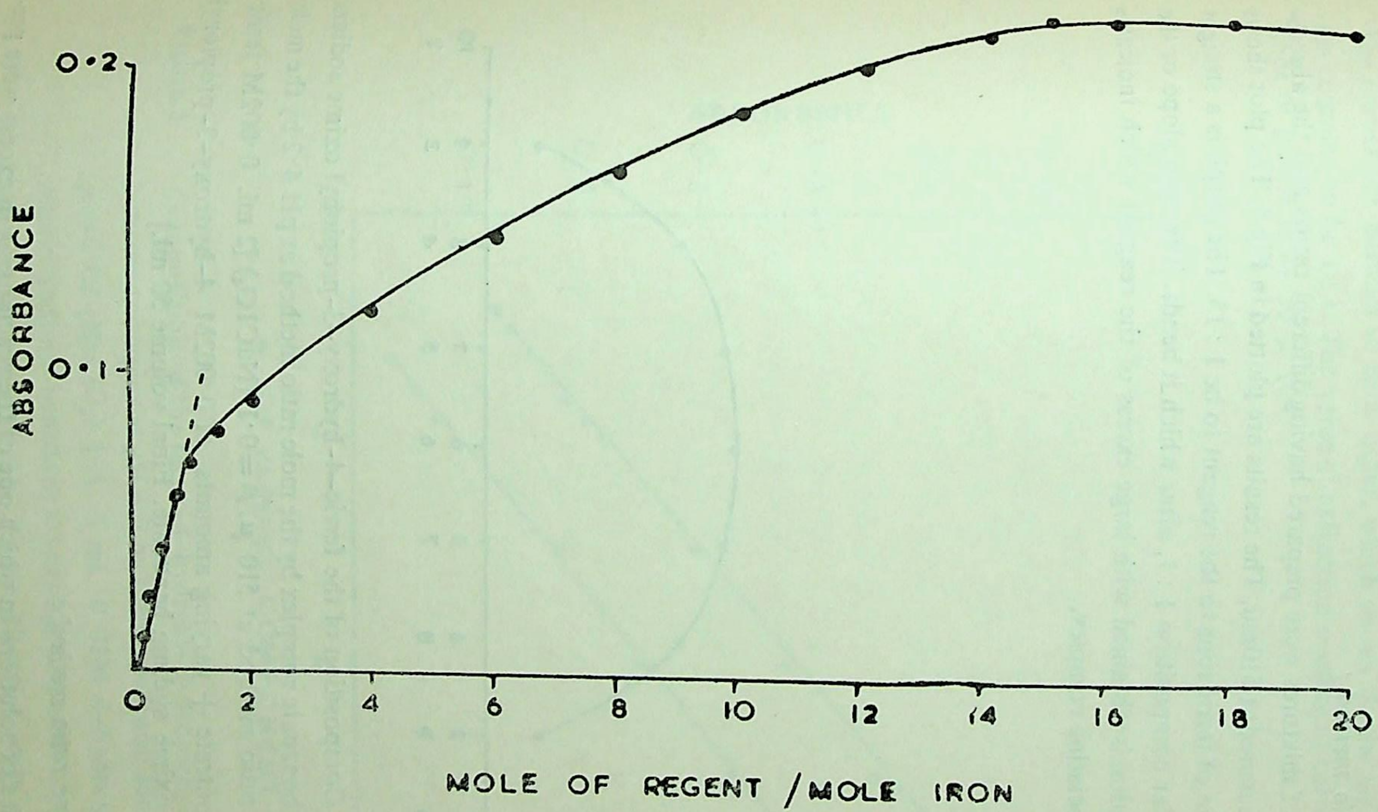

Figure 3 .. Composition of the ferric–4–hydroxy–3–propionyl oxime sodium benzoate complex at pH 4·2 by Job's Method of Continuous Variation using 0·002 M solutions of Ferric nitrate and 4–hydroxy–3–propionyl oxime sodium benzoate. $\mu = 0{\cdot}02$ $NaClO_4$. Final volume 50 ml. 510 mμ.

The formation of 1 : 1 complex is shown by Job's method using equimolar solutions.

(*b*) *Mole ratio method :*

A series of mixtures were prepared having different ratios and the absorbences were measured at 510mu. The results are plotted in Fig.4. The plot shows the molar ratio of ferric ions to the reagent to be 1 : 15. The graph is a straight line upto molar composition 1 : 1, after which it bends. The zero slope or the colour saturation is obtained with large excess of the reagent which indicates a highly dissociating complex.

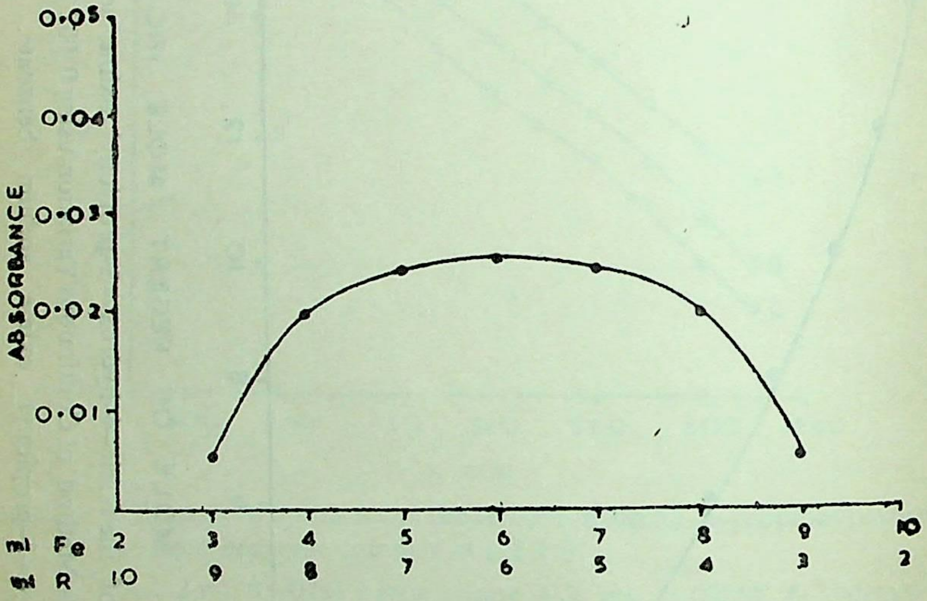

Figure 4 .. Composition of the ferric–4–hydroxy–3–propionyl oxime sodium benzoate complex by the mole ratio method at pH 4·2 by the mole ratio method at 510 μ. $\mu = 0·1$ ($NaClO_4$) [2 ml. 0·002M ferric nitrate + varying amounts of 0·002M 4–hydroxy–3–propionyl oxime sodium benzoate. Final volume 50 ml.]

(*c*) *The slope ratio method :*

Two series of solutions in which one of the reactants is in excess were prepared. The absorbences of these mixtures were measured at 510 mu and plotted against the concentration of variable reactant. The results are shown in Fig. 5. The curves are parallel to each other, which shows the molar composition of the complex to be 1 : 1. The value of extinction coefficient calculated from the slope of plot A is $24 \cdot 50 \times 10^2$.

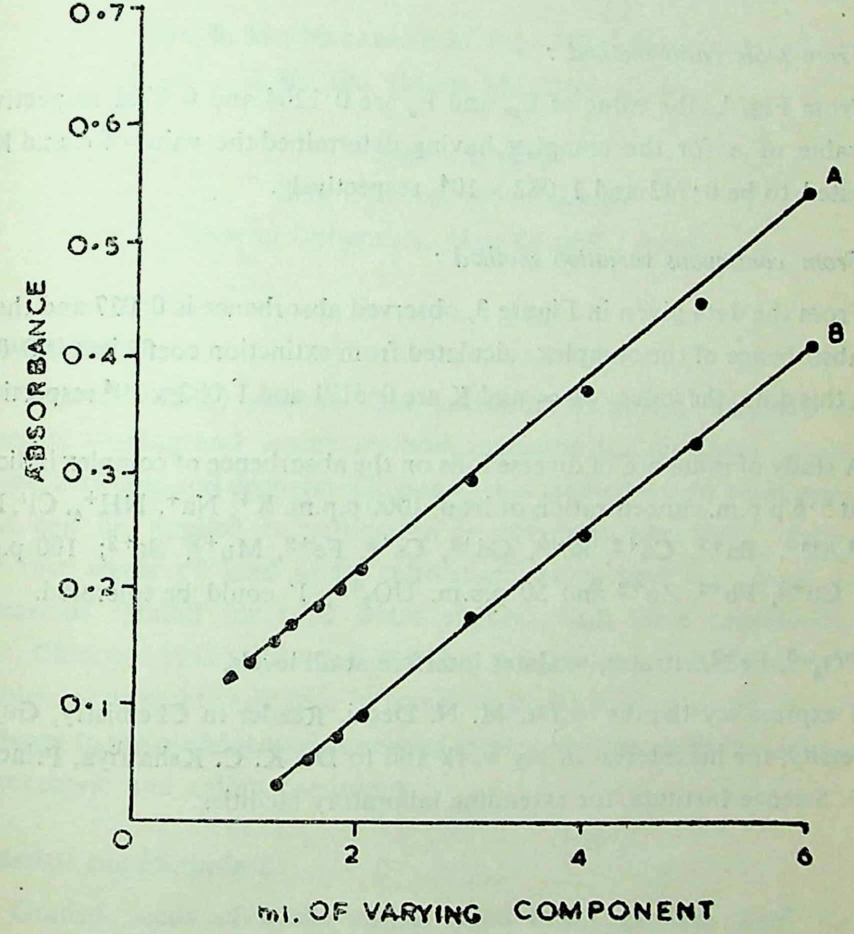

Figure 5 .. Composition of the ferric–4–hydroxy–3–propionyl oxime sodium benzoate complex at pH 4·2 by the Slope Ratio Method at 510 mμ. $\mu = 0 \cdot 02$ ($NaClO_4$) [A. 5 ml. 0·01M 4–hydroxy 3–propionyl oxime sodium benzoate + varying amounts of 0·002M Ferric nitrate. B. 5 ml. 0·01M Ferric nitrate + varying amounts of 0·002M 4–hydroxy–3–propionyl oxime sodium benzoate. Final volume 50 ml.].

Sensitivity and Optimum Concentration Range

A solution containing 0·040 ug/cm^2 Fe^{+++}gave a transmitance difference of 0·2% with the corresponding blank. Hence the sensitivity is 0·040 p.p.m. (Sandell scale).

Evaluation of Stability Constants

(*a*) *From mole ratio method :*

From Fig. 4, the value of E_m and E_s are 0·2204 and 0·0701 respectively. The value of *n* for the complex having determined the value of α and K are calculated to be 0·742 and $1 \cdot 082 \times 10^4$ respectively.

(*b*) *From continuous variation method :*

From the data given in Figure 3, observed absorbence is 0·037 and theoretical absorbence of the complex calculated from extinction coefficient is 0·0588. From this data, the values of $\propto$ and K are 0·5121 and $1 \cdot 092 \times 10^4$ respectively.

A study of influence of diverse ions on the absorbence of complex indicated that at 5·6 p.p.m. concentration of iron, 1000 p.p.m. K^+, Na^+, NH^+_4, Cl', NO_3', SO_4^{-2},Al^{+3}, Ba^{+2}, Ca^{+2}, Be^{+2}, Cd^{+2}, Cs^{+2}, Fe^{+2}, Mn^{+2}, Sr^{+2}; 100 p.p.m. Cr^{+3} Cu^{+2}, Pb^{+2}, Zn^{+2} and 50 p.p.m. UO_2^{+2}, I′ could be tolerated.

PO_4^{-3}, Fe^{+2}, citrates, oxalates interfere at all levels.

I express my thanks to Dr. M. N. Desai, Reader in Chemistry, Gujarat University, for his interest in my work and to Dr. K. C. Kshatriya, Principal, M. G. Science Institute, for extending laboratory facilities.

EFFECT OF PRESOWING HARDENING TREATMENTS AND GROWTH MEDIA ON THE RATE OF SEEDLING GROWTH IN WHEAT VARIETY

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Introduction :

Genckel (1938) showed that presowing hardening treatment by the alternate soaking and drying method, increased the resistance of plants to atmospheric and soil droughts. Obviously this method would be of great value if it can be applied to cultivation in countries like India where there are vast tracts of land under cultivation, which have to depend upon a precarious rainfall for their water supply. With these considerations in view, Chinoy (1942) initiated and then progressed a detailed study of the problem of drought resistance in many crop plants. This paper adds further evidence to the usefulness of presowing treatment of seeds to the unfavourable atmospheric and saline conditions.

Materials and Methods :

Graded seeds of wheat variety New Pusa–718 were used for this experiment. They were subjected to presowing hardening treatment (a modified method of Genckel and Kolotova, 1938) in which the seeds were soaked in distilled water as well as ascorbic acid solutions (with two concentrations of 25 mg./1 and 50 mg/1) and were allowed to absorb moisture up to 35% of thier weight and kept in a swollen condition for 6 hours at about 25° C. These were, then, spread out in a thin layer for drying in shade for 2–3 days. During this period the seeds got dried almost to the original weight. This treatment was repeated three times.

Fifteen pretreated (T) and untreated (C) seeds were placed in 9 cm. Petri dishes on sterilized filter papers, and germinated under the following four conditions provided at the beginning of the experiment :

1. Adequate moisture supply—5 ml. water per dish.
2. Restricted moisture supply—1 ml. water per dish.
3. Adequate quantity of saline medium—5 ml. of 0.1 M. NaCl.
4. Restricted quantity of saline medium—1 ml. of 0.1 M. NaCl.

In the first and third treatments water or NaCl solution were replenished as and when necessary so as to maintain an adequate supply for the germinating seeds; while on the other hand, 1·0 ml. of either water or 0·1 M. NaCl solution were added every 24 hours in the second and the fourth treatments respectively for the first six days and subsequently adequate quantities of either water or NaCl solution were added.

Different combinations of pretreated (T) and control (C) seeds and the medium of germination have been described in the text by combining the serial number of the latter with the abbreviation of the former. Thus, for instance. 2-T means that the seeds were given presowing hardening treatment and were germinated in 1 ml. of water and so on.

During germination tests the number of seedlings attaining different stages of growth were recorded at regular intervals of 24 hours. The following are the critical growth stages of seedling (Fig. 1) :

Stage-1 Coleorhiza just emerging.
Stage-2 Plumule just emerging from the seed coat and the radicle about 5 mm. in length.
Stage-3 Two lateral roots developing, coleoptile still colourless.
Stage-4 Coleoptile becoming green and 1-2 cm. long.
Stage-5 First leaf just emerging and about 1 cm. long.
Stage-6 First leaf 3-4 cm. long.
Stage-7 First leaf half unfolded.
Stage-8 First leaf fully unfolded and second leaf just emerging.
Stage-9 Second leaf 2-4 cm. long.
Stage-10 Second leaf about half the length of the first leaf.
Stage-11 Second leaf just equal in length to the first leaf.

Then, the number of seedlings at a particular growth stage was multiplied by the mean dry weight of the growth stage. Further, the sum of dry weights of seedlings at different stages of growth on a sampling date was taken as the total dry weight of all the germinated seedlings under that treatment and the result was expressed in mg. of dry weight per 100 seedlings (mean dry weights for growth stages are given in Fig. 1 as histograms). Moreover, the relative seedling growth rate was determined from these dry weights by making use of

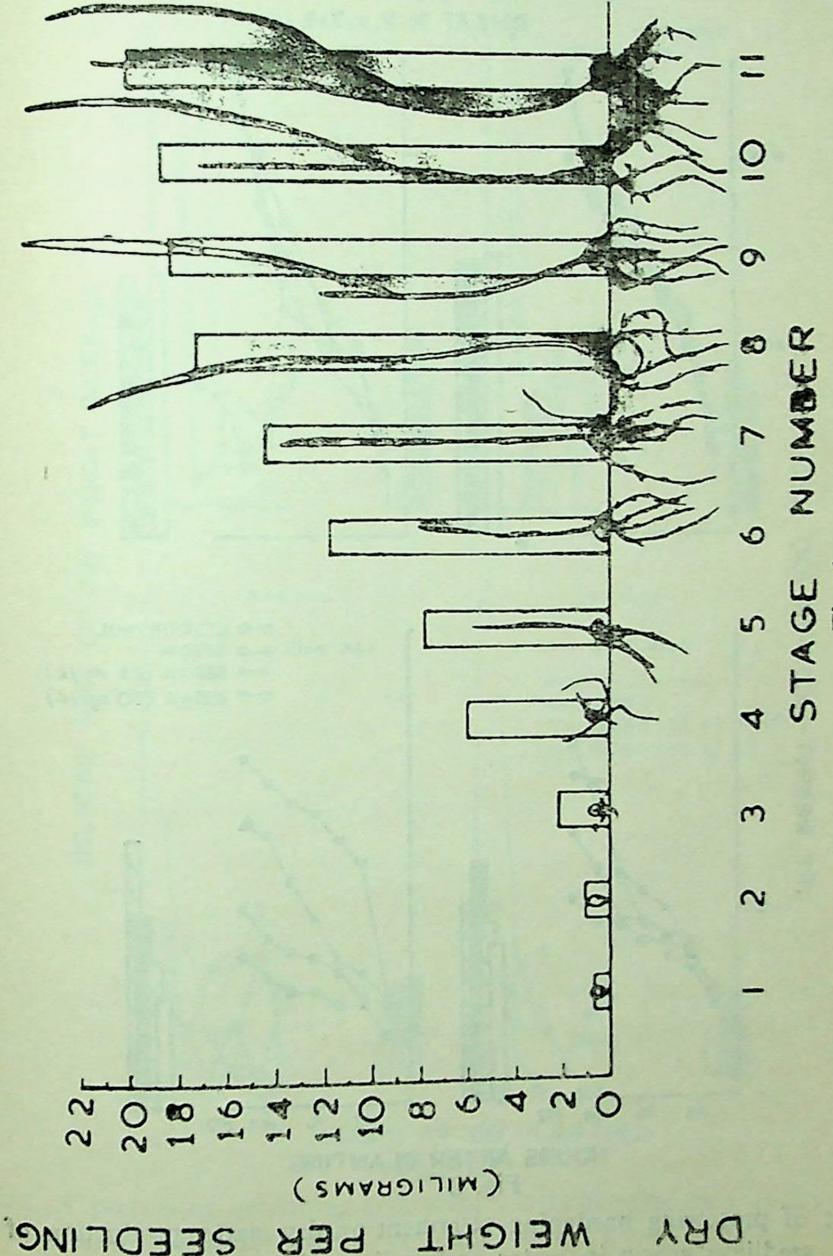

Fig. 1

Average dry weight of seedlings at various well marked stages of their growth.

"compound interest" formula of Blackman (1919) for relative growth rate. Per cent germination was recorded in every dish after itervals of 24 hours and the growth stages attained by these seedlings were determined by comparison with those already shown in Fig. 1.

Results and Discussion :

Data of dry weight (in mg.) per 100 seedlings and relative rate of dry weight increase under four treatments are given in Figs. 2 and 3. It can be seen from these

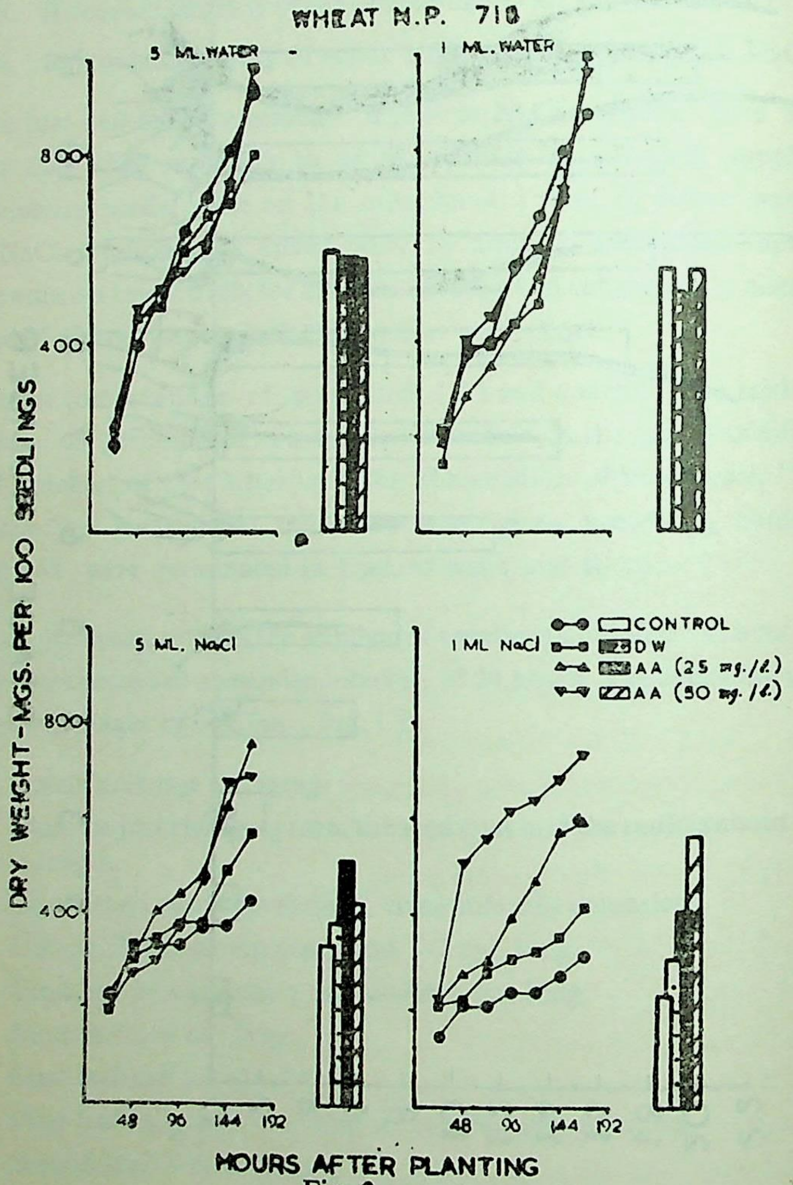

Fig. 2

Effect of presowing hardening treatment on dry matter production of seedlings grown in water and sodium chloride solutions.

figures that the untreated and pretreated seeds show greater dry matter production as well as relative growth rate under adequate water and saline media in comparison with the restricted ones. Further, the seeds under 3–T and 4–T treatments produce greater dry matter when compared with 3–C and 4–C. In both these treatments, seeds pretreated with ascorbic acid solution remain at the highest level for dry matter production. Treatments 1–C, 1–T, 2–C and 2–T do not show any significant effect on dry matter production. Moreover, it is interesting to note that the pretreated seeds under treatments 2–T, 3–T and 4–T continue to produce dry matter after a comparable growth stage of untreated ones, which fail to do so (Table 1).

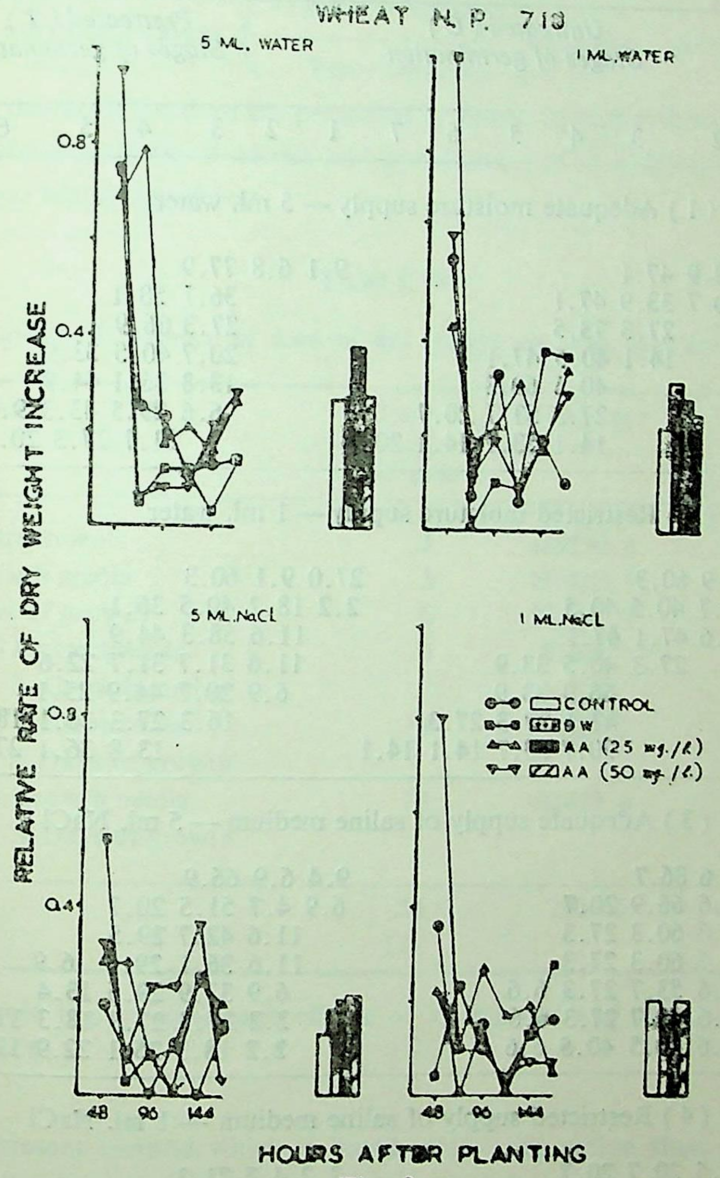

Fig. 3

Effect of presowing hardening treatment on the relative rate of dry matter production in seedlings grown in 5 ml. water, 1 ml. water, 5 ml. and 1 ml. NaCl solutions.

TABLE I

Per cent germination in different stages of growth

Hours from sowing	*Untreated (C) Stages of germination*							*Pretreated (T) Stages of germination*						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
(1) Adequate moisture supply — 5 ml. water														
24	20.7	33.9	47.1					9.1	6.8	77.9				
48		20.7	33.9	47.1						36.1	58.1			
72			27.3	73.5						27.3	66.9			
96			14.1	40.5	47.1					20.7	40.5	33.9		
120				40.5	60.3					13.8	36.1	44.9		
144				27.3	53.7	20.7				6.6	29.5	43.3	9.1	
168				14.1	53.7	14.1	20.7				31.7	27.3	20.7	
(2) Restricted moisture supply — 1 ml. water														
24	6.6	33.9	60.3					27.0	9.1	60.3				
48		20.7	40.5	40.5				2.2	18.2	40.5	36.1			
72		6.6	47.1	47.1					11.6	38.3	44.9			
96			27.3	40.5	33.9				11.6	31.7	31.7	22.6		
120				66.9	33.9				6.9	20.7	44.9	25.1		
144				47.1	27.3	27.3				16.3	27.3	36.1	18.5	
168				20.7	53.7	14.1	14.1				13.8	36.1	27.3	20.7
(3) Adequate supply of saline medium — 5 ml. NaCl														
24		6.6	86.7					9.4	6.9	66.9				
48		6.6	66.9	20.7				6.9	4.7	51.5	20.7			
72		6.6	60.3	27.3					11.6	42.7	29.5			
96		6.6	60.3	27.3					11.6	36.1	29.5	6.9		
120		6.6	53.7	27.3	6.6				6.9	33.9	29.5	13.4		
144		6.6	53.7	27.3	6.6				2.2	27.3	27.3	18.3	11.6	
168		6.6	40.5	40.5	6.6				2.2	18.3	25.1	22.9	11.4	4.7
(4) Restricted supply of saline medium — 1 ml. NaCl														
24		40.5	20.7	20.7				2.2	4.7	71.3				
48			60.3	20.7					6.9	53.7	18.2			
72			60.3	20.7					4.4	46.8	27.3			
96			53.7	20.7	6.6				4.4	40.2	22.9	11.6		
120			53.7	20.7	6.6				2.2	33.6	25.1	18.2		
144			47.1	20.7	14.1				2.2	27.0	29.6	18.2	2.2	
168			47.1	14.1	14.1	6.6			2.2	22.6	29.5	16.3	9.1	

It is worth noting that except treatment-4 the relative growth rate of pretreated plants are higher when compared with untreated ones under all the treatments.

Analysis of variance of data of dry weight per 100 seedlings was carried out and only the F values $\left(\frac{\text{Treatment variance}}{\text{Error variance}}\right)$ together with the corresponding degree of freedom are presented in Table 2. These data show that the factors like pretreatments, media and growth periods as well as their all inter actions are highly significant.

TABLE II

Analysis of variance of data of dry weight per 100 seedlings

Factor	*Degree of freedom*	*Variance*	*F value*
(A) Pretreatments	3	611180.6	21.0 S
(B) Growth media	3	258260.7	88.9 S
(C) Days of growth	6	521310.1	179.4 S
(A X B) Pretreatments X Growth media	9	37408.9	12.9 S
(A X C) Pretreatments X Days of growth	18	4706.2	16.2 S
(B X C) Growth media X Days of growth	18	21439.6	7.4 S
Error	54	2906.6	..
Total	111	..	..

S : Denotes highly significant effects of treatments and their interactions (P>0.01).

The present method which is based upon germination stage-dry weight relationship of seedlings provides a rapid method for the determination of the seedling growth rate. Further, the acceleration in the growth rate of seedling raised from pretreated seeds is due to the acceleration in the amylase and catalase activities of pretreated seeds (Nanda et al., 1959).

ACKNOWLEDGEMENT

We wish to express our sincere gratitude to Professor J. J. Chinoy for his kind interest and unfailing encouragement at every stage of this work.

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ORTHOHYDROXY KETONES AND THEIR OXIMES AS INDICATORS FOR THE EDTA TITRATIONS OF FERRIC IONS

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ABSTRACT

Orthohydroxy propiophenone, orthohydroxy butyrophenone and their oximes are satisfactory indicators for the direct EDTA titration of ferric ions. Titrations can be accurately carried out in the pH range 2–3·5. A large number of diverse ions are tolerated.

* * *

Orthohydroxyacetophenone oxime[1], orthohydroxy propiophenone oxime[1] and orthohydroxy butyrophenone[2] oxime have been investigated as colorimetirc reagents and reagents for spot test detection of iron. The corresponding ketones have not been used as analytical reagents so far. This article reports results obtained in investigations of these compounds as indicators for the complexometric titrations of iron.

The ketones give a violet colour with ferric ions whereas ketoximes give a brown colour with ferric ions.

Experimental

Ferric nitrate solution.

A stock solution of ferric nitrate (0·1M) was prepared by dissolving 40·389 gms. ferric nitrate nonhydrate in distilled water and making upto 1 litre. It was standardised gravimetrically as ferric oxide.

EDTA solution :

A stock solution of 0·1M di Na salt of EDTA was prepared by dissolving 3·72 gms. of EDTA in 1 litre of distilled water.

Indicator solutions :

1% solutions were prepared from pure samples of the reagents by dissolving the requisite amount in 95% alcohol. The solutions were stable upto 4 weeks.

Metal solutions :

To study the interference of various foreign ions in the estimation of iron III with EDTA, the corresponding analar quality of salts were taken and their 0.2M solutions prepared in distilled water.

Effect of pH :

Iron III could be estimated accurately in the pH range 2–3·5 with the help of the compounds investigated.

Effect of Indicator Concentration :

It was observed that 1 ml. of 1% solution of the indicator was satisfactory.

Suggested procedure :

Take an aliquot of ferric solution in beaker, add 5 ml. of acetate-HCl buffer of pH 2 and 1 ml. of indicator. The colour becomes violet in case of ketones and brown in case of ketoximes. Titrate with 0·01M EDTA. At the end point, the colour becomes sharp yellow.

To investigate the effect of foreign ions, titrations of synthetic solutions were carried out at pH 2·0, maintaining the pH by acetate-HCl buffer. At 2·8 mg. concentration of iron, 50 times excess of Na^+, NH_4^+, Cl', Br', SO_4'', No_3'; SO_2^{++}, Be^{++}, Zr^{++++}, Th^{++++}, Pd^{++}; 10 times excess of Ag^+, Ni^{++}, Co^{++}, Mg^{++}, Mn^{++}, Al^{+++}; 2 times excess of Zn^{++}, Cd^{++}, Ca^{++}, Sr^{++}, Ba^{++}, Pd^{++}, Cr^{+++}, Cu^{++} could be tolerated. Anions forming stable complexes with Fe interfered at all levels.

We thank the University Grants Commission for the award of a senior research fellowship to one of us (M.H.G.) and to the University authorities for extending laboratory facilities.

SYNTHESIS OF
7-CHLORO-2-MERCAPTO-3-ARYL-QUINAZOL-4-ONES

G. S. MEWADA,* G. R. DAVE** and G. C. AMIN***

SUMMARY

7-Chloro-2-mercapto-3-aryl-quinazol-4-ones have been synthesised by the condensation of the (*i*) mono-arylthioureas, and (*ii*) arylisothiocyanates. They gave 2-thiophenyl and 2-thiobenzoyl derivatives. Further, they are oxidised to the corresponding quinazol-2 : 4-diones, whose structures have been confirmed by comparison with the condensation products of 4-chloro anthranilic acid with mono-arylureas.

Due to the structural similarity of quinazoline derivatives to quinoline compounds, a good deal of work has been carried out on quinazoline derivatives in order to compare their reactivity and usefulness as potential pharmacologically active compounds. However, comparatively littel work appears to have been done on sulfur containing quinazoline compounds.

In continuation of our work [1-a, b, c, d] on 2-mercapto-derivatives of quinazol-4-one, we have synthesised nine new 7-chloro-2-mercapto-3-aryl-quinazol-4-ones (II, X=H) by condensing 4-chloro anthranilic acid (I) with monosubstituted aryl-thioureas as well as with aryl-isothiocyanates. These compounds contain the reactive mercapto (-SH) group in 2-position. That this group is ' thiol ' and not ' thion ' has been proved by preparing the corresponding 2-thiophenyl (II, X=Ph), 2-thiobenzoyl (II, X=COPh) derivatives (Tables II and III) by the action of bromobenzene and benzoyl chloride respectively.

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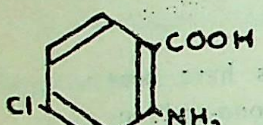
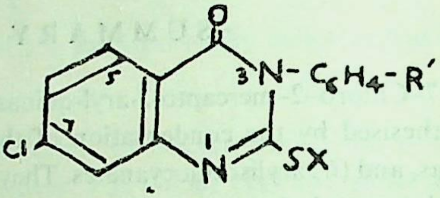
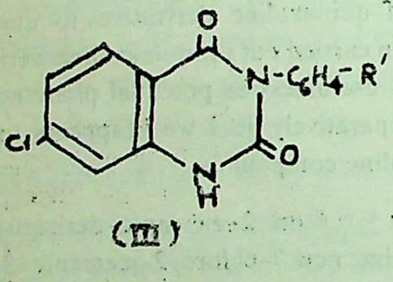
Further, when the chloro-quinazol-4-ones (II, X = H) were oxidised by the alkaline hydrogen peroxide, the mercapto group was affected but 7-chloro-2-hydroxy-3-aryl-quinazol-4-ones (IIIa) were not formed; only the corresponding diketo-products, viz. 7-chloro-3-aryl-quinazol-2 : 4-diones (III) were isolated. So far, the attempts to isolate the enol form (IIIa) in all such compounds studied by us were unsuccessful. The constitution of these 2 : 4-diketo-products was confirmed by direct comparison with authentic samples prepared from 4-chloro anthranilic acid (I) and the corresponding mono-substituted ureas.



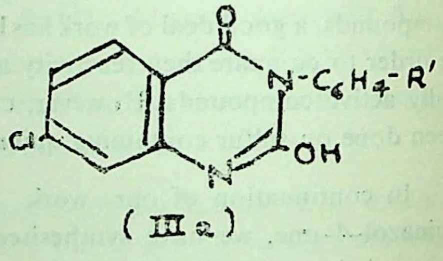
(I)



(II, X = H, Ph, COPh)



(III)



(IIIa)

Experimental

4-chloroanthranilic acid (I) (m.p. 236°) was prepared$^{2-a, b}$ by the oxidation of 4-chloro-2-acetamino toluene$^{3-a, b}$ by means of potassium permanganate and subsequent hydrolysis by hydrochloric acid$^{4-a, b}$ (15%).

The different quinazol-4-one derivatives prepared by the general procedures described below have been listed in Tables I to IV. The solvent used for the crystallisation of the compounds listed in Tables I and IV was ethanol and for those in Tables II and III was acetone. All compounds crystallised as colourless needles.

General Procedures

7-Chloro-2-mercapto-3-aryl-quinazol-4-one (II, X = H) :

(*a*) An intimate mixture of 4-chloroanthranilic acid (I, 10 m.mol) and mono-substituted thiourea (10 m. mol) was heated at 180-90° for two hours, keeping a long tube as a condenser. The brownish mass obtained on cooling was extracted twice with warm (about 50°) NaOH (IN) and filtered off. The filtrate was cooled by ice and acidified by cold dilute HCl (15%). The white product was washed with sodium bicarbonate solution (5%) and crystallised.

(*b*) An ethanolic solution of 4-chloro anthranilic acid (I, 5 m.mol) and the aryl isothiocyanate (5 m. mol) was refluxed for 1-2 hours and the ethanol removed by distillation. The brownish residue was extracted as in (*a*) and the product crystallised. It was found to be identical with (*a*).

7-Chloro-2-thiophenyl-3-aryl-quinazol-4-one (II, X = Ph) :

A mixture of the above quinazol-4-one (II, X = H, 0·5 gm.) in bromobenzene (10 ml.), anhydrous potassium carbonate (0·5 g.) and a little copper powder was heated at 165-70° for 5 hours and the excess of unreacted bromo benzene removed by steam distillation. The solid obtained on filtration of the residual liquid was crystallised.

7-Chloro-2-thiobenzol-3-aryl-quinazol-4-one (II, X = COPh) :

The solution of the quinazol-4-one (II, X = H; 0.5 g.) in NaOH (30 ml.; 2N) was treated with benzoyl chloride (0·5 g.) and kept for 6 hours with occasional shaking. The solid obtained was filtered, washed with water and crystallised.

7-Chloro-3-aryl-quinazol-2:4-dione (III) :

(*c*) The solution of the 2-mercapto-quinazol-4-one (II, X = H, 0 5 g.) in 2N NaOH (50 ml.) and hydrogen peroxide (6 Vol., 10 ml.) was stirred for two hours at 28-30° and filtered. The filtrate on acidification by HCl (15%) gave a solid which was crystallised. This compound was found to be identical with an authentic sample prepared as described below.

(*d*) An intimate mixture of 4-chloro anthranilic acid (I, 0·5 g.) and monosubstituted urea (0·5 g.) was heated at 180-90° for 2 hours. The solid obtained, after extraction with warm 1N NaOH and on acidification, was crystallised and was found to be identical with (*c*) above.

TABLE I

7-Chloro-2-mercapto-3-aryl-quinazol-4-ones (II. X = H)

Sr. No.	Substituent (R′)	M.P °C	Formula	% Nitrogen Cal.	% Nitrogen Found	% Sulfur Cal.	% Sulfur Found
1.	H	328	$C_{14}H_9N_2OSCl$	9·93	9·67	11·09	10·92
2.	2′—Me	304	$C_{15}H_{11}N_2OSCl$	9·38	9·30	10·58	10·41
3.	3′—Me	238	$C_{15}H_{11}N_2OSCl$	9·38	9·11	10·58	10·33
4.	4′—Me	322	$C_{15}H_{11}N_2OSCl$	9·38	9·24	10·58	10·42
5.	2′—OMe	298	$C_{15}H_{11}N_2O_2SCl$	8·90	8·77	10·05	9·78
6.	4′—OMe	318	$C_{15}H_{11}N_2O_2SCl$	8·90	8·63	10·05	9·90
7.	2′—Cl	307	$C_{14}H_8N_2OSCl_2$	8·02	7·80	9·91	9·78
8.	3′—Cl	293	$C_{14}H_8N_2OSCl_2$	8·02	7·88	9·91	9·67
9.	4′—Cl	300	$C_{14}H_8N_2OSCl_2$	8·02	7·80	9·91	9·81

TABLE II

7-Chloro-2-thiophenyl-3-aryl-quinazol-4-ones (II, X = Ph)

Sr. No.	Substituent (R′)	M.P. °C	Formula	% Sulfur Cal.	% Sulfur Found
10.	H	218	$C_{20}H_{13}N_2OSCl$	8·78	8·89
11.	2′—Me	188	$C_{21}H_{15}N_2OSCl$	8·45	8·29
12.	3′—Me	196	$C_{21}H_{15}N_2OSCl$	8·45	8·20
13.	4′—Me	204	$C_{21}H_{15}N_2OSCl$	8·45	8·30
14.	2′—OMe	178	$C_{21}H_{15}N_2O_2SCl$	8·11	8·39
15.	4′—OMe	196	$C_{21}H_{15}N_2O_2SCl$	8·11	8·23
16.	2′—Cl	167	$C_{20}H_{12}N_2OSCl_2$	8·02	7·89
17.	3′—Cl	164	$C_{20}H_{12}N_2OSCl_2$	8·02	8·28
18.	4′—Cl	197	$C_{20}H_{12}N_2OSCl_2$	8·02	8·23

TABLE III

7-Chloro-2-thiobenzoyl-3-aryl-quinazol-4-ones (II, X = COPh)

Sr. No.	*Substituent (R')*	*MP. °C*	*Formula*	*% Sulfur* *Cal.*	*Found*
19.	H	187	$C_{21}H_{13}N_2O_2SCl$	8·15	7·80
20.	2′—Me	152	$C_{22}H_{15}N_2O_2SCl$	7·87	7·58
21.	3′—Me	167	$C_{22}H_{15}N_2O_2SCl$	7·87	7·82
22.	4′—Me	193	$C_{22}H_{15}N_2O_2SCl$	7·87	7·70
23	2′—OMe	171	$C_{22}H_{15}N_2O_3SCl$	7·57	7·30
24.	4′—OMe	183	$C_{22}H_{15}N_2O_3SCl$	7·57	7·70
25.	2′—Cl	166	$C_{21}H_{12}N_2O_2SCl_2$	7·49	7·38
26.	3′—Cl	178	$C_{21}H_{12}N_2O_2SCl_2$	7·49	7·20
27.	4′—Cl	168	$C_{21}H_{12}N_2O_2SCl_2$	7·49	7·67

TABLE IV

7-Chloro-3-aryl-quinazol-2 : 4-diones (III)

Sr. No.	*Substituent (R′)*	*M.P. °C*	*Formula*	*% Nitrogen* *Cal.*	*Found*	*% Chlorine* *Cal.*	*Found*
28.	H	300	$C_{14}H_9N_2O_2Cl$	10·28	10·11	13·03	12·67
29.	2′—Me	296	$C_{15}H_{11}N_2O_2Cl$	9·77	9·61	12·39	11·93
30.	3′—Me	287	$C_{15}H_{11}N_2O_2Cl$	9·77	9·62	12·39	12·18
31.	4′—Me	302	$C_{15}H_{11}N_2O_2Cl$	9·77	9·62	12·39	12·12
32.	2′—OMe	279	$C_{15}H_{11}N_2O_3Cl$	9·26	9·06	11·73	11·48
33.	4′—OMe	271	$C_{15}H_{11}N_2O_3Cl$	9·26	9·11	11·73	11·90
34.	2′—Cl	313	$C_{14}H_8N_2O_2Cl_2$	9·14	8·96	19·19	18·96
35.	3′—Cl	311*	$C_{14}H_8N_2O_2Cl_2$	9·14	9·02	19·19	18·86
36.	4′—Cl	298	$C_{14}H_8N_2O_2Cl_2$	9·14	8·82	19·19	19·30

* Dokunikhin and Gaeva[5] as well as Kizber and Glagoleva[6] who prepared this compound following different routes report the melting point 309-311° and 312° respectively.

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GERMINATION OF AKINETES IN DICHOTOMOSIPHON TUBEROSUS (A. BR.) ERNST

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SUMMARY

Dichotomosiphon tuberosus (A. Br.) Ernst, described in this paper has been collected in the first week of February 1968, from a slow-moving stream in Lunawada, Panchmahals District, Gujarat. The plant has been cultured in the laboratory and the mode of germination of akinetes has been studied in detail. The present observation is the first of its kind in the Indian *Dichotomosiphon.*

INTRODUCTION

The records on the occurrence of *Dichotomosiphon tuberosus* (A. Br.) Ernst, in different parts of India, are available through the works of Randhawa (1942), Chohan and Patel (1957), Sharma and Moghe (1957), Venkataraman (1961), Saxena (1962). Among the Indian workers, only Sharma and Moghe (1957) have reported the presence of akinetes in this species. They have not given any account on the mode of germination of akinetes. Ernst (1902) has reported the germination of akinetes in *Dichotomosiphon.* Our present observations are hand in hand with the observations of Ernst (1902).

OBSERVATIONS

Dichotomosiphon tuberosus (A. Br.) Ernst, described in this paper was collected in the first week of February 1968, from Vehri-pool of Lunawada, Panchmahals District, Gujarat. It was growing in a slow-moving stream, along with *Lyngbya* sp. Few filaments were fertile showing both oogonia and antheridia. The morphology and the dimensions of both the vegetative filaments and sex-organs are exactly similar to that of *Dichotomosiphon tuberosus* (A. Br.) Ernst, described by earlier workers (Ernst, 1902; Virieux, 1911; Puymaly 1917; Chohan and Patel, 1957; Nurul Islam, 1965).

The authors tried to grow the plants in the laboratory, by keeping some healthy vegetative filaments, under natural light and room-temperature, in Godward's culture solution (Godward, 1942). The culture solution was changed at an interval of fifteen days. The growth of the plants was satisfactory and they survived in the laboratory for about three months. No sex-organs developed in the culture.

Within a few days after the transformation of the plants into the culture solution, profuse development of akinetes had been observed. The akinetes were formed at the tips of long, colourless rhizoid-like filaments arising from the ends of dichotomous branches. They were brownish black in colour and of irregular shapes such as club-shaped, curved and more or less spirally coiled (Figs. 1-4). The mode of development of akinetes was the same as that which described by earlier workers (Ernst, 1902; Puymaly, 1917; Sharma and Moghe, 1957). The akinetes were cut off from the rhizoid-like branches by thick septa, and they were up to 5.5 m.m. in length and 260·0 μ in diameter.

The akinetes separated from the vegetative filaments were transferred to 1% agar medium in Godward's culture solution, and were allowed to grow under natural light and room-temperature. Within one week they showed germination. At first, small protrusions were formed near the rhizoidal ends of the akinetes (Fig. 1). These protrusions got elongated to form the filaments which were grass-green in colour. In majority of the cases these filaments developed constrictions and dichotomous branchings, and finally became normal filaments showing all the typical characters of *Dichotomosiphon* (Figs. 5 — 7). But in few cases retention of a single filament, at the rhizoidal end, which was unbranched and non-constricted, was observed (Figs. 2 and 7). They may probably constitute the rhizoidal system of the plant. Filaments were also arising from the sides of the akinetes, slightly away from the rhizoidal ends (Figs. 6 and 7). But there was not even a single case which showed the formation of vegetative filaments from the distal end of the akinetes. Development of more than one plant from a single akinete was very common (Fig. 6). A maximum number of four plants developing from a single akinete had been observed.

DISCUSSION

The morphology and mode of development of akinetes have been described by various earlier workers (Ernst, 1902; Collins, 1909; Virieux, 1911; Sharma and Moghe, 1957). Among these workers only Sharma and Moghe (1957) have reported the spirally coiled akinetes. The datas regarding the dimensions of akinetes have only been given by Collins (1909) and Virieux (1911). According to Collins the maximum length of the akinete is 400.0 μ, while Virieux has observed a maximum length of 3.5 mm. Our present observations show that the length of the akinete is even up to 5.5 mm.

Ernst (1902) has reported the germination of akinetes in *Dichotomosiphon*, and has figured the germinating akinete with one plant only. In the present case we have observed the development of more than one plant (up to four) from

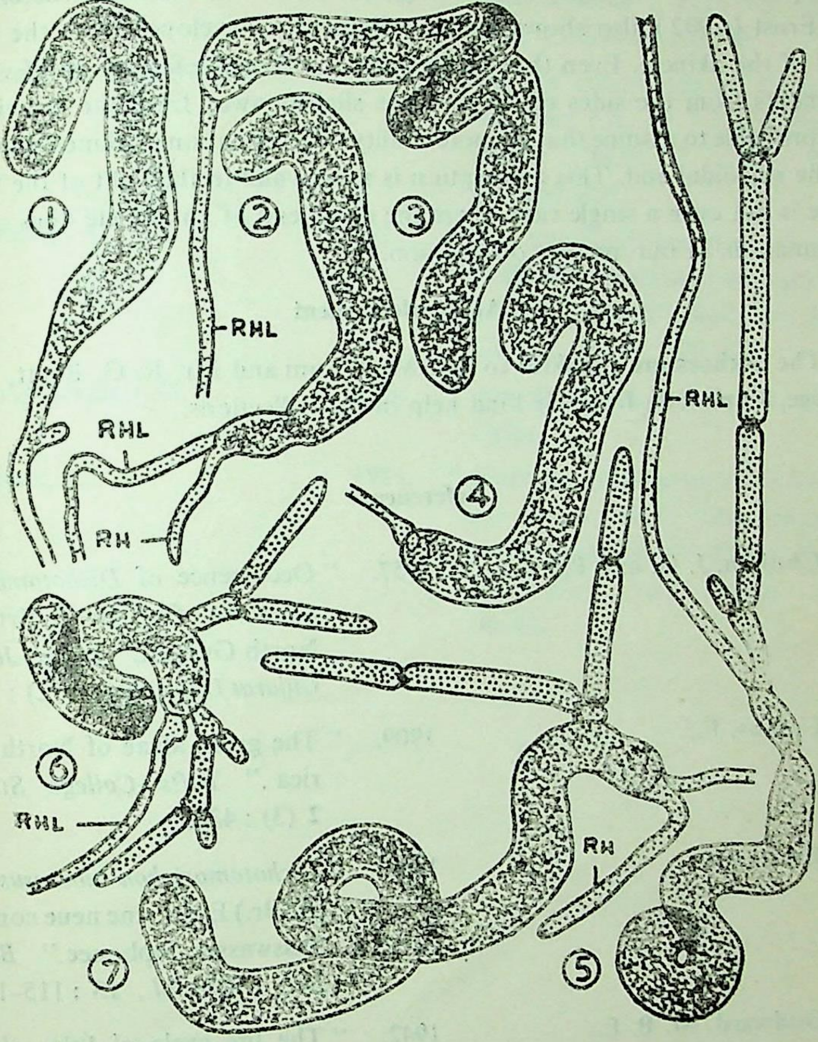

PLATE I : *Dichotomosiphon tuberosus* Ernst

Fig. 1 : Akinete at the initial stage of germination showing a small protrusion at the rhizoidal end.

Figs. 2–4 : Akinetes of different shapes.

Figs. 5–7 : Akinetes after germination showing filaments arising from the rhizoidal end proper and slightly away from the rhizoidal end.

RH — Newly formed rhizoid.

RHL — Old rhizoid-like colourless filament.

(All Figures X about 27.5)

a single akinete. The reported case of germination of akinete in *Dichotomosiphon*, by Ernst (1902) also shows that the filament is developed from the rhizoidal end of the akinete. Even though we have observed the formation of vegetative filaments from the sides of the akinetes slightly away from the rhizoidal end, it is probable to assume that the potentiality of germination of akinetes is confined to the rhizoidal end. This assumption is more valid in the light of the fact that there is not even a single case where the distal end of an akinete does show the germination, in our present observation.

Acknowledgement

The authors are thankful to Mr. M. J. Soni and Mr. R. G. Bhatt, Science College, Lunawada for their kind help in the collections.

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CONNATION IN CLERODENDRUM INERME GAERTN

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Summary

Anatomical differences in the normal and fasciated stem of *Clerodendrum inerme* are described. Variations are in the size and shape of the epidermal cells; number of cortical layers and thickness of the cortical cells.

Introduction

Gorter (1965) reviewed the common phenomenon of fusion of vegetative branches. The present paper deals with the morphology and anatomy of connated branches of *Clerodendrum inerme* Gaertn.

Observations

One large branch of a single plant of *C. inerme* exhibited connation and the smaller branches arising from this branch appeared flat. In one case three branches were found fused up to a distance of 15 cm. covering many nodes and internodes (Fig. 1). Figure 2 illustrates the fusion between two branches, which extends up to the growing point (Fig. 3). The number of leaves varied from node to node.

The fusion of two or more branches was indicated by one or more constrictions in the axial vasculature (Fig. 4). The branches retained their individuality as no leaf trace was found at the axial vascular region of constriction (Fig. 4).

The axial vasculature became narrower towards the tip of the branch. Here one of the connated branches became free. The following anatomical variations were found in normal and fasciated branches:

Table I. Anatomical variations found in normal and fasciated stems of *C. inerme*.

Tissue	Normal branch (Fig. 5)	Fused branch (Fig. 6)
Epidermis	Cells isodiametric	Cells narrow, long and sometimes crushed
Cortex	5–6 layers, two-three layers of chlorenchyma	10–15 layers, peripheral three layers very much thick walled, 5–6 layers of chlorenchyma

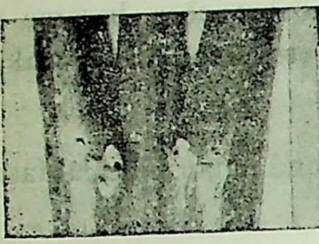
Discussion

Lopriore (1904) pointed out that fasciated roots after exposure to mechanical pressure could also assume the normal round shape again. According to Gunckel and Sparrow (1954) multiple growing points could be induced by ionising irradiation. Time of sowing also influenced fasciation in a quantitative way in *Crepis* and *Taraxacum* (DE Vries, 1903). Although numerous factors are assumed to induce connation and fasciation (Gorter, 1965), we are uncertain about the factor that causes connation in *C. inerme*.

In jute, the normal and fasciated stem anatomy shows that the number of epidermal layers, number of outer and inner cortical layers and the nature of epidermal and cortical cells are similar (Kundu and Rao, 1960). While in *C. inerme*, as described earlier, they differ in normal and fasciated stems. The cells of the outer cortical layers are thick walled in fasciated stem in contrast to those of the normal stem.

However, we would like to add that probably parasitism and/or periodical pruning also could play a role in bringing about connation or fasciation.

Figures



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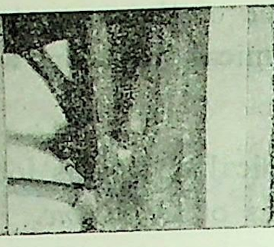

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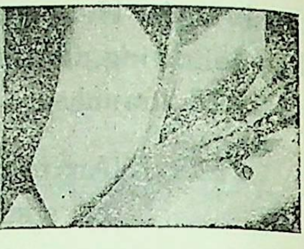

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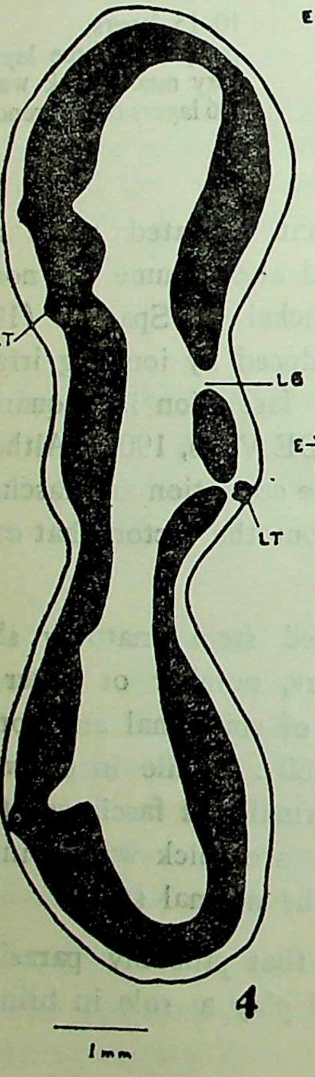

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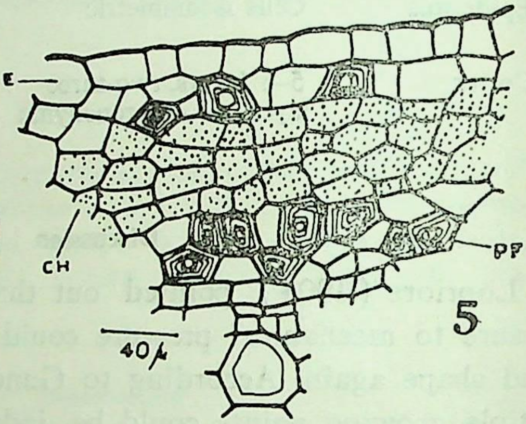

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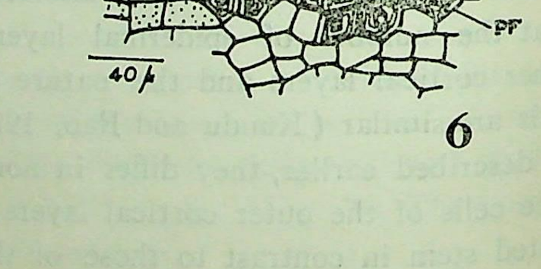

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Acknowledgement

We are thankful to Prof. J. J. Shah for his helpful criticism and encouragement.

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Explanation of Figures

Fig. 1. Connation of three branches;
Fig. 2. Connation of two branches;
Fig. 3. Connation of many branches, note the connation near the shoot apex;
Fig. 4. C. S. of connated branch;
Fig. 5. Cellular details of a portion of c. s. of a normal branch;
Fig. 6. Cellular details of a fused branch in c.s.

(AV–axial vasculature; CH–chlorenchyma; E–epidermis; LG–leaf gap; LT–leaf trace; PF–phloem fibers; SC–sclerenchyma.)

A NOTE ON A NORMED LINEAR SPACE

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Let S be the set of all determinants of order $(2m+1)$. As before we shall denote the determinants by $D_1, D_2, \ldots. Dm$. Each D_r is supposed to contain positive elements. There may be present in some rows or columns common factors. If α is a total common factor in D_r, we shall denote such determinant by $D_{r,\alpha}$ and we shall consider $D_{r,\alpha}$ and $D_{r,\beta}$ to be equivalent so long as they are of the type D_r. We shall take D_0 to denote that determinant in which k does not occur as a common factor any where in the corner determinants.

Let us now agree to accept the following laws of vector addition and scalar multiplication

Addition : $D_{p,\alpha}+D_{q,\beta}=D_{r,\gamma}$

where $p+q=r\ [\mathrm{mod}\ (m+1)]\ \&\ p\neq q, \Upsilon=\min\ (\alpha,\beta)$

$$D_{p,\alpha}+D_{p,\beta}=D_{p,\alpha+\beta}$$

Scalar multiplication : $c\ D_p,\alpha=D_{p},|c|\alpha$ where c belongs to the field of real numbers.

Under these operations the set S with elements of the type $D_0, D_1, D_2, \ldots\ldots\ldots\ldots, D_m$ will form a vector space.

Associativity is clearly satisfied. D_0 is the identity. D_p and $D_{(m+1-p)}$ are additive inverses of each other.

$$a\ (D_{p,\alpha}+D_{q,\beta})=a\ D_{r,\gamma}=D_{r,|a|\gamma}$$

$$aD_{p,\alpha}+aD_{q,\beta}=D_{p,|a|\alpha}+D_{q,|a|\beta}=D_{r,|a|\gamma}$$

Hence $a\ (D_{p,\alpha}+D_{q,\beta})=aD_{p,\alpha}+a\ D_{q,\beta}$.

Other laws can be similarly verified keeping in view that $D_{r,\alpha}$ & $D_{r,\beta}$ are to be considered as equivalent.

Now we define a norm to this space as follows :

$\| D_{p,\alpha} \| = | \alpha | \, p = \alpha p \geqslant 0$; If $\| D_{p,\alpha} \| = 0$, then $D_{p,\alpha}$ reduces to the identity D_0.

$\| \lambda D_{p,\alpha} \| = \| D_{p, \, |\lambda| \alpha} \| = | \lambda | \alpha p = | \lambda | \, \| D_{p,\alpha} \|$

Also $\| D_{p,\alpha} \| + \| D_{q,\beta} \| = | \alpha | p + | \beta | q \geqslant \gamma r \geqslant \| D_{p,\alpha} + D_{q,\beta} \|$

Hence the above vector space now turns out to be a normed linear space.

A STUDY OF ENERGY REQUIREMENT AND GROWTH PERIOD OF BARLEY

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SUMMARY

This experimental work was undertaken with a view to working out the photothermic energy requirement of early and late flowering varieties of barley in relation to their growth period under field conditions.

Taking the mean of photothermic quanta for early sown plants of each variety for the two seasons, it is evident that the photothermic energy requirement of the early variety is $1 \cdot 78 \times 10^6$ and that of the late flowering one $2 \cdot 22 \times 10^6$ substracting the photothermic quantum of late sown plants of each variety from the corresponding values for each early sown ones vernalization quantum of the variety can be obtained. It is $0 \cdot 39 \times 10^6$ and $0 \cdot 52 \times 10^6$ for N. P. 20 and Presto respectively.

It is worthy of note that both the photothermic and the vernalization quanta are of higher order of magnitude for the late flowering Presto compared to the early N. P. 20. This result is in conformity with the results obtained for early and late varieties of wheat (Chinoy, 1956) as well as of other crop plants, and highlight the importance of photothermic and vernalization quanta as genetic factors as shown earlier (Chinoy 1966).

The results presented here have shown that there exists a quantitative relationship between the photothermic quantum and the growth period.

INTRODUCTION

There is sufficient evidence to show that the photoperiodic response of a plant is dependent upon temperature (Lang and

Melchers, 1943; Nanda and Hamner, 1958; Chinoy, Nanda, Sirohi and Sawhney, 1959). That the plant requires a certain amount of light for flowering and not necessarily a diurnal alternation of light and dark periods has already been shown (Hamner, 1944). Chinoy (1956) found a close relationship between the developmental process in wheat and the total amount of photothermic energy supplied to it in a given time.

MATERIALS AND METHODS

Early and late sowings of two varieties of *Hordeum vulgare*, varieties N. P. 20 and Presto, an early and late flowering Indian and Swedish variety respectively, were made for the purpose of this study, during 1960–61; 1961–62.

Details of materials and methods have already been described elsewhere (Chinoy, 1956; Mansuri, 1958).

RESULTS

Data of growth period, photoquantum and thermic quantum of varieties N. P. 20 and Presto under different field sowings are given in table 1.

TABLE I

Growth period and photothermic quanta of two varieties of barley under different sowing times for two successive years.

Year	*Variety*	*Sowing*	*Growth period*	*Photo quantum*	*Thermic quantum*	**Photo-thermic quantum*
1960–'61	N. P. 20	Early sowing	84	909·69	1829·10	1·66
,,	N. P. 20	Late ,,	65	733·32	1500·08	1·10
,,	Presto	Early ,,	89	979·05	1968·40	1·93
,,	Presto	Late ,,	70	793·74	1623·83	1·29
1961–'62	N. P. 20	Early sowing	87	971·24	1958·00	1·90
,,	N. P. 20	Late ,,	53	615·12	1467·45	0·90
,,	Presto	Early ,,	103	1141·71	2195·80	2·50
,,	Presto	Late ,,	61	731·54	1519·60	1·08

*Multiply the values by 10^6.

It will be observed that the growth period is reduced in later sowings and prolonged in earlier sowings. The varietal effects are quite significant. Thus variety Presto has a longer growth period as compared with the early variety N. P. 20.

Photo and thermic quanta are less in late sowing than in early sowing in both varieties. It is worthy of note that the values of photo and the thermic quanta are higher in a variety having a longer growth period. Thus for example, late variety Presto has greater photo and thermic quanta for different field sowings during both the seasons.

Hence it becomes evident that a late flowering variety requires a greater amount of photothermic energy to complete its development compared to early variety.

DISCUSSION

Data presented here supports the concept of photothermic quantum of Chinoy (1956). The time of flowering of the barley variety is determined by the rate at which energy is supplied to the plant. In the case of plants under late sowing conditions, flowering occurs earlier because during the earlier part of the growth period the temperature (especially night temperature during December–January) is lower compared to that received by early sown plants thus causing natural vernalization of late sown plants. This increases the photosensitivity of the plant and therefore lesser photothermic energy is required for flowering. The difference between the photothermic quantum of early and late sown plants must therefore be considered as vernalization quantum of a variety (Chinoy, 1956).

ACKNOWLEDGEMENT

The author is grateful to Professor J. J. Chinoy, Botany Department, Gujarat University, Ahmedabad, India, for guidance during this work.

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CORRELATION BETWEEN PRODUCTION OF GROWTH CENTRES AND PHOTOTHERMIC ENERGY REQUIREMENT OF BARLEY

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SUMMARY

This paper deals with the energy requirement of the plant in relation to the production of growth centres.

Observations presented here have clearly brought out the fact that the rate of supply of photothermic energy to the plant in a given time plays a vital role in laying down of growth centres and differentiation of different organs of the spikelet.

INTRODUCTION

In a previous communication (Mansuri, 1969) it has been shown that there is a close correlation between the photothermic energy and the growth period.

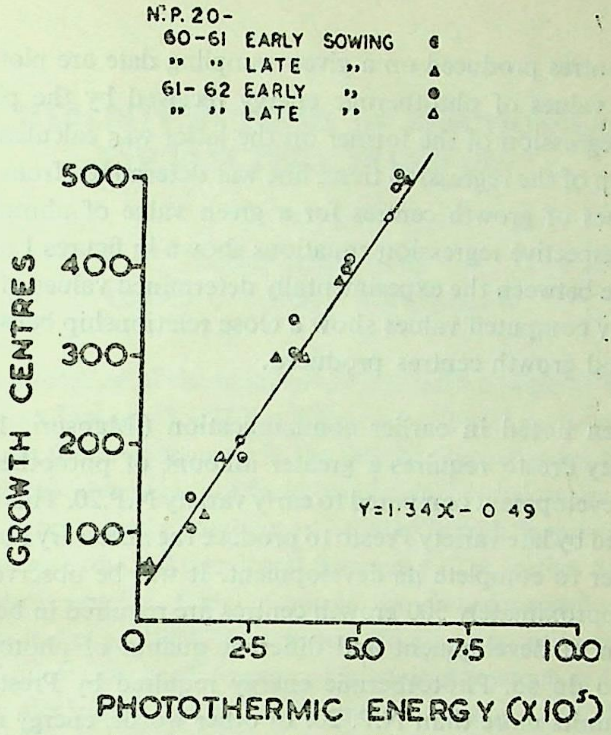
This concept is further elaborated in the present paper by establishing a quantitative relationship between the energy requirement and the growth centres produced in the developing spike.

Materials and Methods

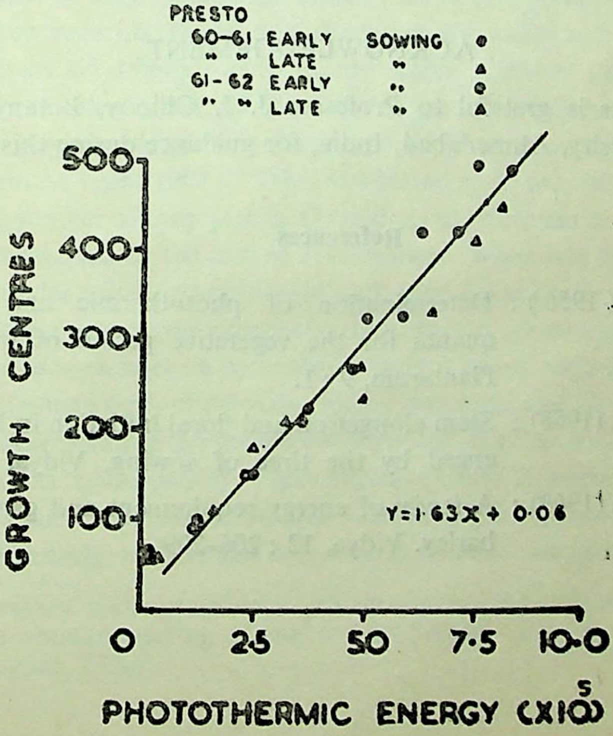
Early and late sowings of two varieties of *Hordeum vulgare,* varieties N.P. 20 and Presto, Indian and Swedish variety respectively, differing in the length of their growth period, were carried out for this study.

Details of materials and methods have already been described elsewhere (Chinoy, 1956; Mansuri, 1968).

The amount of photothermic energy required to produce a given number of growth centres in the spike at any given sampling date was calculated by multiplying the mean diurnal rate of supply of photothermic energy during the period of reproductive differentiation by the number of days elapsing between the stage of double ridges and the given date. The data are presented in figures 1 and 2.



Growth centres produced on a particular date includes glume, lemma, palea, stamen, carpel primordia of the main spike and the number of leaves on the plant.



Results

Growth centres produced on a given sampling date are plotted against the corresponding values of phtothermic energy received by the plant in figures 1 and 2. The regression of the former on the latter was calculated in each case and the position of the regression trend line was determined from the statistically computed values of growth centres for a given value of photothermic energy based on the respective regression equations shown in figures 1 and 2. The close correspondence between the experimentally determined values of growth centres and statistically computed values show a close relationship between the energy requirement and growth centres produced.

It has been noted in earlier communication (Mansuri, 1969) that late flowering variety Presto requires a greater amount of photothermic energy to complete its development compared to early variety N.P.20. This is because more energy is needed by late variety Presto to produce the necessary number of growth centres in order to complete its development. It will be observed from figures 1 and 2 that approximately 500 growth centres are required in both the varieties for completion of development and different quanta of photothermic energy are required to do so. Photothermic energy required by Presto is $2{\cdot}5 \times 10^5$ photothermic units more than N.P. 20. In other words, energy requirement for the development of late variety Presto up to the stage of anthesis is greater compared to that in N.P. 20.

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The author is grateful to Professor J. J. Chinoy, Botany Department, Gujarat University, Ahmedabad, India, for guidance during this work.

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HEREDITY IN TERMS OF REACTION RATES AND ELECTRON TRANSPORT*

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The annual meeting of the members of the Indian Society for Plant Physiology was held on January 3, 1970 at Kharagpur. Besides several activities, the society fosters recent developments in the field of plant physiology by organising symposia and inculcates a spirit of frank and lively discussions on specific themes. This year too, it organised a seminar on ' Plant Growth Regulators ' in collaboration with the section of Agricultural Sciences of the Indian Science Congress Association. Professor J. J. Chinoy one of the founder members of the Society was its President during 1969. He selected the above mentioned subject for his Presidential Address. A brief resume of his address which is in the course of publication in the Indian Journal of Plant Physiology, 1970 is given below :

During the course of the last thirty years, extensive work in our laboratory on the dynamics of major metabolic events such as biosynthesis of nucleic acids, protein, enzyme-proteins, lipids, carbohydrates and other cell constituents not only of cultivars of different crop plants under different photoperiodic and vernalization treatments, but also of heterozygous population has conclusively proved the dependence of growth symmetry of a plant upon the rate of its development (Chinoy, 1966; 1968). " This was found to be true in the case of many cultivars of a number of crop plants. Growth in the different organs of the plant was strictly controlled by the rate of development. When late flowering cultivars were placed under a long photoperiod and given vernalization treatment, thus accelerating their rate of development, their growth symmetry was completely changed in such a manner as to conform to that of an early flowering one. In other words a pheno copy of an early cultivar was produced. A similar result was obtained by deccelerating the rate of development of an early cultivar by putting them in a short photoperiod. Phenocopies of late flowering cultivars were obtained. A similar result was obtained when segregating hybrid populations of crosses between early x early and late x early parents were grown under varying photoperiods with and without vernalization treatment. The growth symmetry exhibited by the segregating hybrid was controlled by its rate of development.

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* A summary of the presidential address delivered by Professor J. J. Chinoy at the annual meeting of the Indian Society for Plant Physiology at Kharagpur, 1970.

Considering the fact that the rate of development of a plant is governed by the rate of nucleic acid — protein metabolism as well as rates of biosynthesis of other metabolities and also by rates of enzymic reactions an attempt was made to determine these rates during well marked stages of development of different genetic constitutions differing markedly in their rate of development. Investigations extended over a number of years have conclusively shown that rates of biosynthesis of nucleic acids, protein and other cell constituents as well as rates of enzymic reactions are invariably faster in the early cultivar compared to the late flowering one (i.e. are correlated with the rate of development). Further under the influence of long photoperiod and vernalization treatment the rates of biosynthesis and enzymic reactions in late flowering cultivars are accelerated in such a manner as to become biochemical phenocopies of those of the early flowering one (Chinoy, 1970).

As shown above rates of biosynthesis of metabolites and enzymic reactions determine the rate of development and consequently the growth pattern of a genotype. This is brought about by the action of regulatory substances like ascorbic acid. The rate of biosynthesis as well as the rate of enzymic utilization of the regulatory substance will determine the tempo of metabolism underlying dvelopment and which will ultimately control the partitioning of metabolites and nutrients into various organs of the plant thus giving rise to a particular growth pattern. A regulatory substance like ascorbic acid is a universal participant in the redox system of the plant. Its free radical is produced by the enzymic action of a special peroxidase. Ascorbic acid is also known to participate in the formation of charge transfer complexes (CTC), with macromolecules. The available data on the rate of reaction of AA-FR peroxidase as well as on the rate of complexing of AA with macromolecules in early and late flowering varieties show that they are faster in the former. Free radical content of vegetative apex as well as reproductive organs as determined by Electron Spin Resonance (ESR) Spectra show that rate of free radical formation as well as the rate of CTC formation are faster in the various organs in the early cultivar compared to those of the corresponding organs of a late one. Reproductive parts have higher rates compared to vegetative apex.

On the basis of the above mentioned evidence the postulation about the genetic events advanced earlier (Chinoy, 1966) is further elaborated.

The energy trapping potential the energon (ε) is defined in terms of photothermic and vernalization quanta as

$$\varepsilon = Pt \, \frac{1}{vE}$$

where v is the vernalization quantum and E the photothermic quantum (Chinoy, 1956) and pt, a constant, which in this case is the diurnal rate of supply of photothermic energy.

The ε is further elaborated in terms of rates of formation of free radicals and charge transfer complexes, thus

$$\varepsilon = \frac{1}{F} \cdot RC,$$

where R is the rate of free radical formation, C the rate of CTC formation, and $\frac{1}{F}$ is a constant, viz., the rate of development.

The nucleon, the structural complex of the heredity quantum is presented as

$$n = \varepsilon\ (M.N.a.) = \frac{RC\ (MNa)}{F}$$

where n is the nucleon, ε, a constant, M, the "active mass" of a macromolecule (primer included), a, the rate of synthesis of the 'primary product' of the nucleon which in all probability is ascorbic acid, and N, the rate of production of 'excited' nucleotides.

The metabolon m, which represents the potential of an organism for utilization of energy for metabolic activity on the basis of a given nucleon is given in terms of rates of biosynthesis of nucleic acids and rates of enzymic reactions as follows :

$$m = n\left(drz\right) = \frac{RC\ (MNa)}{F} \cdot drz$$

where d is the rate of DNA replication, r, the rate of m–RNA synthesis and Z, the overall rate of enzymic reactions.

An attempt has been made to visualise the molecular and submolecular aspects of heredity in terms of rates of reactions and energy transport as follows :

> " The photothermic excitation of the energon is extranuclear and is most probably related to the photosynthetic apparatus. Ascorbic acid turnover is augmented by irradiation resulting into the formation of its free radical as well as its complexing with macromolecules. The excitation of the energon is imparted to the nucleon. The excited charge transfer complex breaks upto give rise to nucleotide triplets as well as nucleotide free radicals constituting an energized nucleotide pool. The excitation energy of these nucleotides is imparted to the metabolon for the replication of DNA and consequently of m–RNA and t–RNA. The above mentioned electronic energy and the energy of $\sim p$ regulate the incorporation of aminoacids into structural proteins and enzyme proteins. As DNA – polymerase, protein synthetases and aminoacid t–RNA synthetases also contribute specificity to the replicated DNA strand it can be

said that the determination of nucleic acid nucleotide sequence is not forbidden as asserted by Watson-Crick theory. The rate of electron transport in the form of free radicals and CTC will also be determined by the rate of reaction of a number of enzymes like the AA-FR forming peroxidase as well as other oxidase and reductase enzyme systems which control the AA electron cycle.

The carbon cycle will contribute substantially to the ascorbic acid content of the organism thereby accelerating the formation of charge transfer complexes with macromolecules to generate electron energy and contribute to the free radicals of nucleotides thus participating in the replication of DNA (Chinoy, 1970). The AA-free radical is a more powerful reductant than AA and therefore, is most likely to activate the processes of photophosphorylation as well as oxidative phosphorylation. The ' level ' of the ATP pool will not only depend upon the above mentioned processes but also upon the rate of reaction of the enzyme ATP ase.

In conclusion it can be said that the phenomenon of heredity is controlled by the complex metabolic mechanism of the cell which has many an interlocked nuclear and cytoplasmic gear and which can be kept in motion only by a coordinated system of energy trapping from external sources and biological electron transport ".

Acknowledgement

I thank Professor J. J. Chinoy for permission to make use of the manuscript of his presidential address for preparing this summary.

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A NON-STATIC GENERALIZATION OF GÖDEL'S UNIVERSE

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Summary

In this paper a non-static generalization of Gödel's universe filled with perfect fluid distribution with non-vanishing twist and shear is constructed. If we take the stream lines of the perfect fluid distribution filling the universe to be geodesic, the tensor of twist vanishes. For this reason the non-static generalization of Gödel's universe discussed here possesses a property that the stream lines of the perfect fluid distribution filling it are not geodesic. Some details of the generalization are also discussed.

1. Introduction

The cosmological models based on the assumptions known as cosmological principle and Wyle's hypothesis, lead to several difficulties about the age of the universe and the formation of galaxies. This fact gave rise to several attempts for the modification of the above mentioned two assumptions, one such attempt was to weaken Wyle's hypothesis by the introduction of rotation in cosmological models. The idea of a rotating universe occured to George Gamow[1] in 1946. Kurt Gödel[2] invented the first rotating universe as a solution of Einstein's field equations. This universe is filled with a static distribution of perfect fluid with vanishing pressure and non-zero angular velocity, the stream lines being geodesic. There have been several attempts for a generalization of Gödel's universe. Synge[3] has given a general scheme of static distribution of imperfect fluids with geodesic stream lines and non-zero angular velocity, such that when fluid pressure becomes isotropic the fluid distribution reduces to Gödel's universe. Shepley[4] has also discussed the spatially homogeneous, dust filled cosmological spinning models. Raval and Vaidya[5] have given a non-static generalization of Gödel's universe. Their universe is filled with imperfect fluid, with geodesic stream lines and non-vanishing twist. They have studied the following metric form :

$$ds^2=(dx^0)^2+2e^{x^1}(dx^0)(dx^2)+ae^{2x^1}(dx^2)^2+b(dx^1)^2+c(dx^3)^2 \quad (1)$$

where a, b, c are functions of time x^0 .

If v^i is the four vector of fluid velocity satisfying $v^i v_i = 1$, one can define the acceleration vector f^i and the tensor of twist w_{ik} as

$$f^l = v^l{}_{;k} v^k$$
$$w_{lk} = v_{l;k} - v_{k;l} \tag{2}$$

Here and in what follows a semicolon denotes the covariant differentiation and a comma denotes the partial differentiation. For perfect fluid distribution $f^l = 0$ always imply $w_{lk} = 0^6$.

This can be seen as follows :

The energy momentum tensor $T_k{}^l$ for perfect fluid distribution is given by

$$T_k{}^l = (p + \rho) v^l v_k - p\, g^l{}_k \tag{3}$$

where p is the fluid pressure and ρ is the density of matter. With the help of the conservation low of general relativity $(T_k{}^l)_{;l} = 0$ and the result (3) we obtain the ' equation of motion ' in the form

$$(p + \rho) f_l = p_{,l} - \frac{dp}{ds}\, v_l \tag{4}$$

where $\dfrac{d}{ds} = v^k \dfrac{\partial}{\partial x^k}$

From (4) it is obvious that $f^l = 0$ implies $v_l = p_{,l} \left(\dfrac{dp}{ds}\right)^{-1}$, provided $\dfrac{dp}{ds}$ is not zero. Substituting this v_l in the result $v^l{}_{;k} v_l = 0$ we obtain

$$p_{,l} \left(\frac{dp}{ds}\right)_{,k} - p_{,k} \left(\frac{dp}{ds}\right)_{,l} = 0 \tag{5}$$

From result (5) we conclude that $\dfrac{dp}{ds}$ is a function of fluid pressure p, which in turn implies that the velocity vector v_i is a gradient of a scalar which further implies $w_{ik} = 0$. This indicates that for a non-static generalization of Gödel's universe filled with perfect fluid (and not dust), we must forgo the requirement of geodesic stream lines.

In the early stages of the evolution of the universe it is expected that the radiation will dominate over the matter and therefore the fluid pressure cannot be taken zero. This is the main cause of our interest in perfect fluid distribution and not dust.

Now consider the line-element

$$ds^2 = (dx^o)^2 + 2g_{\mu o}(dx^o)(dx^2) + g_{\mu\gamma}(dx^\mu)(dx^\gamma) \qquad (6)$$

where μ and Υ run from 1 to 3. Here the four vector of fluid velocity v^i is given by

$$v^1 = v^2 = v^3 = 0,\ v^0 = 1,\ v^0 v_0 = 1 \qquad (7)$$

with the help of result (7), $f^i = 0$ imply $\left\{ {i \atop 0\ 0} \right\} = 0.$

As $g_{oo} = 1$, $\left\{ {i \atop 0\ 0} \right\} = 0$ imply $\frac{\partial g_{\mu 0}}{\partial x^0} = 0.$ $\mu = 1, 2, 3.$

This indicates that if we take $g_{\mu o}$ dependent on time x^o, we get non-zero f^i. Thus we take $g_{\mu o}$ as functions of time x^o to obtain a non-static generalization of Gödel's universe filled with perfect fluid.

2. Non-static generalization

We have considered the following line-element for a non-static generalization of Gödel's universe filled with perfect fluid :

$$ds^2 = (dx^0)^2 + 2e^{x^1}\lambda\,(dx^o)(dx^2) + ae^{2x^1}(dx^2)^2 + b\,(dx^1)^2 + c\,(dx^3)^2 \qquad (8)$$

where a, b, c and λ are functions of time x^o. In the present paper we have used −2 for the signature of the metric (8). The determinant g of the metric tensor g_{ij} should be negative. This implies that bc and $a-\lambda^2$ are of opposite signs. However since x^1-direction is space-like, b must be negative.

The field equations of general theory of relativity with a zero cosmical constant are

$$G^i_k = -8\pi T^i_k \qquad (9)$$

where G^i_k are the components of Einstein's mixed tensor. G^i_k are related to Ricci tensor R^i_k by the equations

$$G^i_k = R^i_k - \tfrac{1}{2}\delta^i_k R \qquad (10)$$

The components of the tensor G^i_k are

$$G^1_1 = \frac{a}{2(a-\lambda^2)}\Bigg[\frac{a^{\cdot 2}}{2a(a-\lambda^2)} + \frac{c^{\cdot 2}}{2c^2} + \frac{\lambda^2}{2ab} - \frac{a^{\cdot\cdot}}{a} - \frac{c^{\cdot\cdot}}{c}$$
$$- \frac{(a-2\lambda^2)a^\cdot c^\cdot}{2ac(a-\lambda^2)} - \frac{\lambda a^\cdot \lambda^\cdot}{a(a-\lambda^2)} - \frac{\lambda c^\cdot \lambda^\cdot}{c(a-\lambda^2)}\Bigg] \qquad (11)$$

$$G^2_2 = \frac{a}{2(a-\lambda^2)}\Bigg[\frac{b^{\cdot 2}}{2b^2} + \frac{c^{\cdot 2}}{2c^2} - \frac{b^{\cdot\cdot}}{b} - \frac{c^{\cdot\cdot}}{c} + \frac{\lambda^2 a^\cdot b^\cdot}{2ab(a-\lambda^2)}$$
$$+ \frac{\lambda^2 a^\cdot c^\cdot}{2ac(a-\lambda^2)} - \frac{b^\cdot c^\cdot}{2bc} - \frac{\lambda b^\cdot \lambda^\cdot}{b(a-\lambda^2)} - \frac{\lambda c^\cdot \lambda^\cdot}{c(a-\lambda^2)} + \frac{\lambda^2}{2ab}\Bigg] \qquad (12)$$

$$G^{3}_{3} = \frac{a}{2(a-\lambda^{2})}\left[\frac{\dot{b}^{2}}{2b^{2}} + \frac{\dot{a}^{2}}{2a(a-\lambda^{2})} - \frac{\ddot{a}}{a} - \frac{\ddot{b}}{b} - \frac{(4a-3\lambda^{2})}{2ab} - \frac{(a-2\lambda^{2})\dot{a}\dot{b}}{2ab(a-\lambda^{2})} - \frac{\lambda\dot{b}\dot{\lambda}}{b(a-\lambda^{2})} - \frac{\lambda\dot{a}\dot{\lambda}}{a(a-\lambda^{2})}\right] \tag{13}$$

$$G^{0}_{0} = -\frac{1}{4b(a-\lambda^{3})}\left[\dot{a}\dot{b} + \frac{b\dot{a}\dot{c}}{c} + \frac{a\dot{b}\dot{c}}{c} + 4a - \lambda^{2}\right] \tag{14}$$

$$G_{o} = \frac{1}{4b(a-\lambda^{2})}\left[\frac{\lambda^{2}\dot{c}}{c} + \frac{(2a-3\lambda^{2})\dot{a}}{a-\lambda^{2}} - \frac{(2a-\lambda^{2})\dot{b}}{b} + \frac{2a\lambda\dot{\lambda}}{a-\lambda^{2}}\right] \tag{15}$$

$$G^{0}_{1} = \frac{a}{4(a-\lambda^{2})^{2}}\left[\frac{(2a-3\lambda^{2})\dot{a}}{a-\lambda^{2}} - \frac{(2a-\lambda^{2})\dot{b}}{b} + \frac{\lambda^{2}\dot{b}}{b} - \frac{\lambda^{2}(a-2\lambda^{2})\dot{a}}{a(a-\lambda^{2})}\right] \tag{16}$$

$$G^{0}_{2} = -\frac{\lambda a\, e^{x^{1}}}{b(a-\lambda^{2})} \tag{17}$$

$$G^{2}_{0} = \frac{\lambda}{2e^{x^{1}}(a-\lambda^{2})}\left[\frac{\dot{b}^{2}}{2b^{2}} + \frac{\dot{c}^{2}}{2c^{2}} - \frac{\ddot{b}}{b} - \frac{\ddot{c}}{c} + \frac{\dot{a}\dot{b}}{2b(a-\lambda^{2})} + \frac{\dot{a}\dot{c}}{2c(a-\lambda^{2})} - \frac{\lambda\dot{b}\dot{\lambda}}{b(a-\lambda^{2})} - \frac{\lambda\dot{c}\dot{\lambda}}{c(a-\lambda^{2})}\right] \tag{18}$$

$$G^{1}_{2} = \frac{a\lambda e^{x^{1}}}{4b(a-\lambda^{2})}\left[\frac{\dot{c}}{c} - \frac{\dot{b}}{b} + \frac{(a-2\lambda^{2})\dot{a}}{a-\lambda^{2}} + \frac{2a\dot{\lambda}}{\lambda(a-\lambda^{2})}\right] \tag{19}$$

$$G^{2}_{1} = \frac{a\lambda}{4e^{x^{1}}(a-\lambda^{2})}\left[\left(\frac{a-\lambda^{2}}{a}\right)\left(\frac{\dot{b}}{b} + \frac{\dot{c}}{c}\right) + \frac{2\dot{\lambda}}{\lambda} - \frac{\dot{a}}{a}\right] \tag{20}$$

Here and in what follows an overhead dot indicates differentiation with regard to time x°. For a perfect fluid distribution in co-moving co-ordinates we have for the non-vanishing components of the energy–momentum tensor T^{i},

$$T^{1}{}_{1} = T^{2}{}_{2} = T^{3}{}_{3} = -p,\quad T^{0}{}_{0} = \rho \text{ and}$$
$$T^{0}{}_{2} = (p+\rho)\,v_{2}v^{0} = \lambda\,(p+\rho)\,e^{x^{1}} \tag{21}$$

The field equations $G^{i}{}_{k} = -8\pi T^{i}{}_{k}$ would imply the relations

$$G^{1}{}_{1} = G^{2}{}_{2} = G^{3}{}_{3},\quad G^{\circ}{}_{2} = \lambda\, e^{x^{1}}\,(G^{0}{}_{0} - G^{1}{}_{1}),\quad G^{2}{}_{0} = G^{0}{}_{1} = G^{1}{}_{2} = 0. \tag{22}$$

When the forms of tensor $G^{i}{}_{k}$ in terms of g_{ik} are substituted in (22) we find six differential equations for four functions a, b, c and λ. However it can be varified that $G^{1}{}_{1} = G^{2}{}_{2}$ and $G^{0}{}_{2} = \lambda\, e^{x^{1}}\,(G^{0}{}_{0} - G^{1}{}_{1})$ follow from $G^{0}{}_{1} = G^{2}{}_{0} = G^{1}{}_{2} = 0$. Finally we are left with the following four independent equations for four unkowns a, b, c and λ.

$$G^{0}_{1} = 0 \tag{23}$$

$$G^1_2 = 0 \tag{24}$$

$$G^2_0 = 0 \tag{25}$$

$$G^1_1 = G^3_3 \,. \tag{26}$$

Equations (23) and (24) are easily integrable, giving the solutions

$$b = \alpha a \quad \text{and} \quad \frac{bc\lambda^2}{a-\lambda^2} = \beta \tag{27}$$

where α and β are constants of integration. As bc and $a-\lambda^2$ are of opposite signs, β must be negative. With the help of (27) equations (25) and (26) can be expressed in terms of a and λ as follows :

$$\ddot{a} - \frac{(a^2-\lambda^4+a\lambda^2)\dot{a}^2}{a^2(a-\lambda^2)} - \frac{2a\ddot{\lambda}}{\lambda} - \frac{4a(2\lambda^2-a)\dot{\lambda}^2}{\lambda^2(a-\lambda^2)} + \frac{(a+3\lambda^2)\dot{a}\dot{\lambda}}{\lambda(a-\lambda^2)} = 0 \tag{28}$$

and

$$\frac{2a-\lambda^2}{\alpha a^2} + \frac{(a-2\lambda^2)\ddot{a}}{a(a-\lambda^2)} + \frac{2a\ddot{\lambda}}{\lambda(a-\lambda^2)} + \frac{\lambda^2\dot{a}^2}{a(a-\lambda^2)^2} + \frac{4a(2\lambda^2-a)\dot{\lambda}^2}{\lambda^2(a-\lambda^2)^2} + \frac{(a^2-3a\lambda^2-2\lambda^4)\dot{a}\dot{\lambda}}{a\lambda(a-\lambda^2)^2} = 0 \tag{29}$$

Equations (28) and (29) form a set of two second order non linear differential equations for a and λ. Thus the problem hangs on the solution of these two non-linear equations. Once these equations (28) and (29) are solved b and c will be determined by (27) and all the field variables can be calculated. The pressure and the density of the fluid are determined by

$$8\pi p = -\frac{1}{4a}\left[\frac{(a+\lambda^2)\dot{a}^2}{(a-\lambda^2)^2} - \frac{4\dot{a}\dot{\lambda}a^2}{\lambda(a-\lambda^2)^2} - \frac{\lambda^2}{\alpha(a-\lambda^2)}\right] \tag{30}$$

and

$$8\pi\rho = \frac{1}{4a}\left[\frac{(a+\lambda^2)\dot{a}^2}{(a-\lambda^2)^2} - \frac{4\dot{a}\dot{\lambda}a^2}{\lambda(a-\lambda^2)^2} + \frac{4a-\lambda^2}{\alpha(a-\lambda^2)}\right] \tag{31}$$

Again the angular velocity vector ω^1, the scalar of expansion θ and the non-vanishing components of the shear tensor q_{ij} are given by

$$\omega^i = \delta^i_3(-\beta)^{-\frac{1}{2}}\lambda^2(a-\lambda^2)^{1}$$

$$\theta = \frac{\lambda\dot{a} - \dot{\lambda}(a+\lambda^2)}{3\lambda(a-\lambda^2)}$$

$$q_{11} = \frac{\alpha}{6\lambda(a-\lambda^2)}\left[\lambda\dot{a}(a-3\lambda^2)+2a\dot{\lambda}(a+\lambda^2)\right]$$

$$q_{22} = \frac{e^{2x^1}}{6\lambda}\left[\lambda\dot{a}+2\dot{\lambda}\,(a+\lambda^2)\right]$$

$$q_{33} = \frac{\beta}{6\alpha a^2\lambda^3}\left[\lambda\dot{a}\,(3\lambda^2-2a)+2a\dot{\lambda}\,(\lambda^2-4a)\right]$$

$$q_{20} = q_{02} = \frac{\dot{\lambda}e^{x^1}}{2} \qquad (32)$$

We require that p should be non-negative while ρ should be positive. Equations (30) and (31) imply that

$$8\pi\,(p+\rho) = \frac{1}{\alpha(a-\lambda^2)} \qquad (33)$$

In order that $p+\rho$ be positive it is necessary that $\alpha<0$ and $a-\lambda^2<0$, i.e., $0<a<\lambda^2$.

However if we take $\lambda=1$ and $a=\frac{1}{2}$ the equations (28) and (29) are satisfied. In this case we have $b=$constant, $c=$constant, $\theta=0$, $w^i\neq0$, $q_{ij}=0$ and $f^i=0$. For this choice of a and λ we get the Gödel's static model as a particular case.

3. Approximate solutions of the field equations

We shall now study the approximate solutions of the differential equations (28) and (29) for the values of a and λ which are very close to their corresponding values in Gödel's static model. In Gödel's universe $a=\frac{1}{2}$ and $\lambda=1$.

In the zeroth approximation we put $a=\frac{1}{2}$ and $\lambda=1$. Then we obtain

$$8\pi p=8\pi\rho=-\frac{1}{\alpha},\ \theta=0,\ q_{ij}=0 \text{ and } w^l=-2\delta^l_3\,(-\beta)^{-\frac{1}{2}}.$$

Next, in the first approximation we take $a=\frac{1}{2}+ka_1$ and $\lambda=1+k\lambda_1$, where k is a small quantity of the first order whose squares and higher powers are neglected in this approximation. In this approximation equations (28) and (29) reduce to $\ddot{a}_1-\ddot{\lambda}_1=0$ and $4(a_1-\lambda_1)+\alpha\,(3\ddot{a}_1-\ddot{\lambda}_1)=0$ respectively. The soultion of these equations is $a_1=\lambda_1=x^0$. Hence the first order solutions of (28) and (29) are $a=\frac{1}{2}+kx^0$, $\lambda=1+kx^0$

In this case we find that

$$8\pi p=-\frac{1}{\alpha}+\frac{2k}{\alpha}x^0$$

$$8\pi\rho=-\frac{1}{\alpha}+\frac{2k}{\alpha}x^0$$

$$\theta = \frac{k}{3}$$

$$\omega^i = -2\,\delta^i{}_3(-\beta)^{-\frac{1}{2}}$$

$$q_{11} = \frac{k\alpha}{3}, \qquad {}_2 = \tfrac{2}{3} k e^{2x^1}, \qquad q_{33} = \tfrac{2}{3}\,\frac{\beta}{\alpha} k,$$

$$q_{20} = q_{02} = \frac{k e^{x^1}}{2} \qquad (34)$$

Here it should be noted that the constant k has the dimension of inverse time. The present rate of expansion per unit distance of the universe is believed to be equal to Hubble's constant[7]. Therefore we can take the rate of expansion θ to be equal to Hubble's constant. The value of this constant is about 4×10^{-18} Sec^{-1}.[8] Consequently we have k of the order 10^{-17} Sec^{-1}. We can say from the expression for ρ in (34) that the density becomes negative when $x^0 > \frac{1}{2k}$. As k is of the order 10^{-17} Sec^{-1}, we get the life-time of the model to be $4{\cdot}16 \times 10^{16}$ Sec, i.e., $1{\cdot}31 \times 10^9$ years.

Next in the second approximation we take $a = \frac{1}{2} + k a_1 + k^2 a_2$ and $= 1 + k\lambda_1 + k^2\lambda_2$. In this approximation we have to neglect the terms containing k^3 and higher powers of k. The solutions of (28) and (29) can now be put in the forms

$$a = \tfrac{1}{2} + kx^0 - \frac{k^2 x^{0^4}}{8\alpha}$$

$$\lambda = 1 + kx^0 - k^2\left(\frac{x^{0^4}}{18\alpha} + \tfrac{3}{2} x^{0^2}\right) \qquad (35)$$

With the help of (35), the expressions for p, ρ, θ, w^i and q_{ij} reduce to the following :

$$8\pi p = -\frac{1}{\alpha} + \frac{2kx^0}{\alpha} - k^2\left(1 + \frac{6x^{0^2}}{\alpha} + \frac{x^{0^4}}{4\alpha^2}\right)$$

$$8\pi \rho = -\frac{1}{\alpha} + \frac{2kx^0}{\alpha} + k^2\left(1 - \frac{10x^{0^2}}{\alpha} - \frac{x^{0^4}}{4\alpha^2}\right)$$

$$\theta = \frac{k}{3} - \frac{k^2 x^0}{3}\left(8 + \frac{x^{0^2}}{2\alpha}\right)$$

$$\omega^i = -2\delta_3{}^i(-\beta)^{-\frac{1}{2}}(1 + 2kx^{0^2})$$

$$q_{11} = \frac{k\alpha}{3} + \frac{\alpha k^2 x^0}{3}\left(3 - \frac{x^{0^2}}{2\alpha}\right)$$

$$q_{22} = \tfrac{2}{3} k e^{2x^1} - \frac{k^2}{3} e^{2x^1} x^0\left(3 + \frac{x^{0^2}}{\alpha}\right)$$

$$q_{33}=\frac{2}{3}\frac{\beta}{\alpha}k-\frac{2}{3}\frac{\beta}{\alpha}k^2x^0\left(2+\frac{x^{0^2}}{2\alpha}\right)$$

$$q_{20}=q_{02}=\frac{k}{2}e^{x^1}-\frac{k^2}{2}e^{x^1}x^0\left(3+\frac{x^{0^2}}{2\alpha}\right) \tag{36}$$

Assuming the initital density-$\frac{1}{\alpha}$ to be of order 10^{-35} Sec^{-2} and noting that k is of order 10^{-17} Sec^{-1}, we find that ρ becomes negative when $x^0 > 1 \cdot 5 \times 10^{18}$ Sec. We thus find that the age of the universe in this approximation is 5×10^{10} years. Here it should be noted that the scalar of expansion θ vanishes at two instants say t and t_2, where

$$1 \cdot 25 \times 10^{16} \text{ Sec} < t_1 < 1 \cdot 26 \times 10^{16} \text{ Sec.} \qquad \text{and}$$

$$1 \cdot 26 \times 10^{18} \text{ Sec} < t_2 < 1 \cdot 27 \times 10^{18} \text{ Sec.}$$

Initially θ is positive and it remains positive up to $1 \cdot 25 \times 10^{16}$ Sec. After this instant it vanishes and becomes negative and contraction of the universe starts. θ remains negative from $1 \cdot 26 \times 10^{16}$ Sec to $1 \cdot 26 \times 10^{18}$ Sec. Then again θ vanishes and becomes positive. It remains positive up to time $1 \cdot 5 \times 10^{18}$ Sec. After this instant the density becomes negative and the model loses its physical significance. Of course the period of contraction of the universe is small in comparison with its period of expansion. The angular velocity vector increases with time x^0.

4. Conclusion

In the present analysis we have thus formulated a spinning cosmological model with shear which is expanding. Initially the pressure and density are equal. It is filled with perfect fluid distribution. The special feature of our spinning model is that the stream lines of the fluid distribution filling it are not geodesic. Assuming the proper order of initial rate of expansion, the model will have required lifetime after which the density will be negative and the model will lose the physical significance. The geometry of the model is similar to that of Gödel's stationary model.

In the solution discussed here gravitational theory gives us four equations (23), (24), (25) and (26) for four unknown potential functions a, b, c and λ. But actually three equations for these four unknowns should be given by gravitational theory and the fourth equation should be provided by the equation of state of the perfect fluid distribution filling the universe. Thus with the line-element considered here it is not possible to consider fluid distribution with different equations of state. This in turn may mean that the line-element considered here is not sufficiently general. We are at present trying to work with a more general line-element.

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OBITUARY

Dr. R. C. SHAH : HIS LIFE and WORK

The news of sudden death of Dr. R. C. Shah on 3rd September 1969 came as a shock to a large number of his students, friends and admirers. They were planning to celebrate his 70th birthday on 7th October 1969 in a big way.

Dr. Ramanlal Chhaganlal Shah was born on 7th October 1899 at Pardi, nestling among mango groves, a few miles from Bulsar in South Gujarat. Young Shah studied in the schools at Baroda and Navasari and then joined the Gujarat College, Ahmedabad. He later studied at the Wilson College, Bombay and took the B.A. degree of the Bombay University in 1920 with First Class Honours in Physics and Chemistry. He was appointed a fellow at the Wilson College and he took his B.Sc. degree in 1921. A post-graduate research scholarship took him to the Indian Institute of Science at Bangalore which was then the Mecca of all brilliant students wanting to do research. He worked there under Prof. J. J. Sudborough. He was awarded the M.Sc. Degree by Bombay University for his thesis which also won for him The Moos Gold Medal of the University. He joined the educational service of Bombay Government in 1925 and was posted at the Royal Institute of Science in Bombay. Here he worked till 1929. The Mangaldas Nathubhai Foreign Scholarship of Bombay University enabled him to go to London, to work with Professor Robert Robinson at the University College and when the Professor moved to Oxford, Shah went to Dyson Perrins Laboratory at Oxford to complete his work, for which he was awarded the doctorate. On return to India, he was appointed Head of the Chemistry Department of Ismail Yusuf College at Andheri. Although the College was an intermediate one, Dr. Shah never lost touch with research, as he took his research students at the Royal Institute of Science. In 1939, Dr. Shah was transferred to the Institute as Professor of Organic Chemistry, where he built a flourishing school of research. M.Sc. was then a research degree : over 50 students took their M.Sc. degree and over 25 students took their doctorates under his guidance. Dr. Shah joined the National Chemical Laboratory at Poona in 1950 as Assistant Director and Head of Organic Chemistry Division. He became the Deputy Director in 1959. He retired in 1961 but continued to take a good deal of interest in industrial development and acted as an adviser to a number of pharmaceutical and chemical industries.

Dr. Shah was an excellent teacher. His exposition was lucid and the material up-to-date. His lecture demonstrations enhanced the interest of students in the subject.

Dr. Shah's research was extensive and varied. He worked in the field of pure as well as applied chemistry. He published over 150 papers and was granted 8 patents

In pure chemistry, his work is both in the field of natural products and on the synthetic side. In the field of natural products, he studied the chemistry of oroxylin, a constituent of the root bark of Oroxylum indicum vent; wogonin a constituent of the roots of *Scutellaria baicaleusis*; calycopterin from the leaves of *Calycopteris florinbunda*; cardanol, the main constituent of Cashew nutshell liquid–*Anacardium oc identale* and pristemerin from the [root bark of *Pristmera indica*. The chemical examination of indigenous medicinal plants (*Swertia decussata* and *Swertia chiratta*) was carried out and the chemical structures of swertinin and decussatin established. Geijerin a naturally occurring coumarin derivative and dihydrorobinetin were synthesised. New syntheses of naturally occurring hydroxyxanthones (lichexanthone and gentisein) were also developed.

On the synthetic side, his work related to (1) the synthesis of various imidochlorides and study of their reactions : (2) γ-substitution in resorcinol nucleus and studies on the fixation of double bonds in aromatic nucleus; (3) studies in the synthesis of various oxygen heterocycles such as coumarins, chromones and flavones; (4) nitrogen heterocycles such as quinolines; (5) studies on the pattern of substitution in various Oxygen heterocycles: and (6) synthesis of C–alkyl–resorcinols.

Dr. Shah developed the use of anhydrous aluminium chloride as a condensing agent in the Pechmann reaction which led to the synthesis of 5-hydroxycoumarin derivatives which are otherwise difficultly accessible. Later at National Chemical Laboratory he developed the use of mixture of anhydrous zinc chloride and phosphorus oxychloride as a condensing agent. This reagent has been found to be remarkably effective for the synthesis of organic compounds such as hydroxy-xanthones arylalkyl ketones, desoxy benzoins, chalcones 4 hydroxy-coumarins and 2 : 4-dihydroxy-quinolines. New applications of lithium aluminium hydride and boron trifluoride were also worked out.

Dr. Shah was keenly interested in industrial problems. He investigated the manufacture of Saccharine and Chloramine–T. His process for Chloramine-T was utilised by Government of India during the Second World War for manufacture of anti-gas ointment. He served as Development Officer (Antigas) and established the manufacture of chlorosulphonic acid. He served as Deputy Director of chemicals in the Supply Department of Government of India.

Dr. Shah developed a new synthesis of 4-hydroxy coumarin, the key intermediate for manufacture of blood anticoagulants such as dicoumarol and warfarin, the latter also being extensively used as rodenticide.

Dr. Shah was quiet and unassuming by nature and of retiring disposition. Honours came to him but he never went after them. He was elected fellow of National Institute of Sciences of India and Indian Academy of Sciences. He presided over the Chemistry section of Indian Science Congress (1951), and the Science section of Gujarati Sahitya Parishad in 1949. He was the President of Indian Chemical Society for two years.

Dr. Shah was connected with Gujarat University in various ways. He worked on selection committees and as a referee for various theses. Many of his students are on the staff of various colleges of the University.

The country has lost a good citizen who took keen interest in the development of chemical industries. The world of science has lost a sound organic chemist whose research was not motivated by prospects of material gain or intellectual suobbery or desire for social prestige but by sheer love of it.

We who had the privilege of knowing him and working with him over years mourn the loss of a genuine well wisher and warm hearted personality.

— S. M. SETHNA
— N. M. SHAH

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